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# Annotated Bibliography on Soft X-ray Spectroscopy

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UNITED STATES DEPARTMENT OF COMMERCE • Luther H. Hodges, *Secretary*  
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

# Annotated Bibliography on Soft X-ray Spectroscopy

H. Yakowitz and J. R. Cuthill



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## Preface

Emission and absorption spectra of solids in the 25 to 800 Å range, termed "soft X-ray spectra" by X-ray spectroscopists working up in wavelength from the normal X-ray region, and "far ultra violet spectra" by the optical spectroscopists working down from the visible region, have been observed since the early nineteen thirties. However, the activity was centered in relatively few laboratories until the last decade, during which there has been a rapid expansion of interest in this spectral range. The increase in activity is the result of a number of simultaneous developments. First, the recent developments in ultra high vacuum technology and in detectors for this wavelength region have overcome many of the experimental difficulties. At the same time there has been a sudden expansion in the scope of this region of spectroscopy with the advent of space studies of solar radiation and laboratory research on plasmas as well as solid state physics. These new vistas, and new tools with which to exploit this spectral region, have brought many new people into the field who should find this compilation to be a useful reference.

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# Annotated Bibliography on Soft X-ray Spectroscopy

H. Yakowitz and J. R. Cuthill

About 550 references are contained in this bibliography which includes, it is believed, a complete coverage of the soft X-ray literature since 1950 and through 1960. Some references to earlier work are given but the general review references, listed separately, give an adequate coverage of the earlier work.

The emphasis is on the application of soft X-ray spectroscopy to the study of valence band electronic states in metals and alloys and therefore the spectral region of 25 to 800 angstroms involving ruled glass grating spectrometers is of principal interest. However, a wealth of data have been gathered, primarily by the Russians, on valence electronic states by means of high energy transitions where crystal spectrometers are satisfactory. These references and any X-ray work leading to the distribution of valence electronic states are included regardless of the transitions employed.

In addition to soft X-ray data, references on all pertinent aspects of the apparatus and experimental problems are included. Also listed separately are references of value in corroborating soft X-ray data with other results, such as energy band calculations.

Subject, author, X-ray band, material, and other indices are included.

## Introduction

Soft X-ray spectroscopy, concerned with electron transitions from the valence band to an ionized inner shell, constitutes one of the most direct and universal methods of obtaining the energy distribution of electrons in the valence band in solids. In the soft X-ray literature the term "valence band" is taken to include all of the electrons outside of the outermost filled shell. Generally, the transitions studied are between the valence band and the outermost filled shell, which results in radiation in the 50 Å to 700 Å region. This is low energy radiation compared to that which is customarily employed in X-ray diffraction and in fluorescent analysis, and hence is called "soft". However, some investigators, particularly the Russians, have been utilizing transitions from the valence band to the K shell, even for the very heavy elements. The disadvantage of utilizing these transitions is the necessity of observing small differences in very large energy values. Utilization of these high energy transitions has the advantage, however, of permitting the use of crystal spectrometers rather than ruled glass grating spectrometers. For the purposes of this bibliog-

raphy, all X-ray studies seeking to obtain information on the electronic structure of the valence band are included regardless of the wavelength range utilized.

This bibliography was compiled in connection with a research program on the electronic structure of metals and alloys in progress at the National Bureau of Standards. The bibliography contains about 550 references which constitute, it is believed, a complete coverage of the soft X-ray literature that has appeared since 1950. Some references to work published before 1950 are included, but no attempt has been made to include all of the early work because Volume 1, part 4 of the Landolt-Bornstein Tables contains a systematic summary of the earlier work. The reference sources include, in addition to the regularly published literature, unclassified reports on government sponsored research that are generally available from the Office of Technical Services, Department of Commerce, Washington 25, D.C. In addition to the soft X-ray work itself, material having to do with the interpretation of the soft

X-ray results is included and will be characterized in more detail later in the Introduction.

The first group of references is to general survey and review papers and books which have been written usually in connection with various significant occasions in the course of development of the field of soft X-ray spectroscopy by leading authorities.

The main listing of references then follows, grouped by year and listed alphabetically by author within each year. Under each year the references are further separated into two groups. The first group consists of references concerned specifically with X-ray work, which have been classified under one of three categories: theoretical with no experimental results; contains some experimental results; or description of apparatus only. These categories are designated by a T, E, or A, respectively, following the reference number. The second group under each year has each reference number preceded by a "C" to indicate that the material is not X-ray work but is corroborative to the X-ray results. No attempt was made to make the coverage of corroborative material as complete as that of the soft X-ray papers because this would have resulted in a prohibitively long list. Therefore, only a selected list of corroborative material is given. The intention was to include the most useful data in connection with the analysis and evaluation of soft X-ray data. The corroborative material is limited primarily to energy band calculations and bond structure discussions. These references also carry suffix of T, E, or A, having the same connotation as in the case of the X-ray work.

The annotations under each reference are in the following form:

1. Type of data.
2. Method.
3. Results.
4. Conclusions.

One or more of these headings may not apply to a particular reference, in which case that number or numbers are omitted from the list.

A number of indexes are given, at the front of the Bibliography, for ready reference to papers that contain the specific data to which the index applies. No attempt has been made, in the General Subject Index at the rear of the Bibliography, to duplicate any subject heading covered by the specific indexes at the front. Therefore, references that give data only may be listed only under a specific index at the front and will be found in the General Subject Index only if there is something in the paper pertaining to one of the subject headings given in the General Subject Index.

The spectra have been presented in the literature in a variety of energy units. In compiling this bibliography the units given in the original paper in each case were retained. A chart is appended to the bibliography for convenience in converting from one unit to another. Each cycle is identical in so far as the locations of the lines are concerned, and only the multiplying factors will change, corresponding to the wavelength range designated. For example, 40 Å is seen from the chart to correspond to approximately 310 eV, whereas 400 Å corresponds to approximately 31 eV, and continuing the chart would give 3.1 eV corresponding to 4 Å.

It is planned to continue this bibliography and to issue supplements periodically. The authors would appreciate suggestions regarding significant omissions or corrections.

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The authors thank Dr. M. L. Williams of this laboratory for his suggestion of the wavelength conversion chart and for the compilation of it. The authors also express their sincere appreciation to Prof. E. L. Jossem, Prof. D. H. Tomboularian and Dr. J. E. Holliday for their helpful comments and suggestions.



# INDEX OF ELEMENTS

Atomic No.	Element	Papers	Atomic No.	Element	Papers
3	Li	1934(1); 1937(1); 1940(5); 1950(9), (10); 1951(6); 1952(13); 1954(12); 1955(17); 1956(20); 1958(10), (33), (C-2); 1959(8), (9), (28); 1960(11), (12), (15), (18), (C-4).	17	Cl	1935(2); 1936(3), (4); 1951(14), (20); 1954(15); 1955(14), (23), (37), (38), (C-8); 1957(3), (4); 1958(24); 1959(30); 1960(3), (44).
4	Be	1934(1); 1938(1); 1940(5); 1951(6); 1953(1), (C-4); 1954(12); 1955(33), (34); 1956(C-11); 1957(7), (26); 1958(10), (28); 1959(9); 1960(17), (29), (31), (43).	18	A	1955(C-6); 1959(33).
5	B	1940(5); 1951(6); 1958(C-7), (C-18); 1957(24); 1960(29), (C-14).	19	K	1935(2); 1936(3), (4); 1941(1); 1951(11), (12), (14); 1952(18); 1954(15); 1955(14), (17), (24), (35), (C-5); 1956(16); 1957(3), (30), (34); 1958(10), (24), (C-2); 1959(30); 1960(10).
6	C	1940(5); 1951(6); 1952(C-4); 1953(1), (C-4); 1955(9); 1956(18), (C-1); 1957(24); 1958(C-4), (C-6), (C-18); 1959(16), (C-6), (C-15); 1960(17), (29).	20	Ca	1935(2); 1936(3), (4); 1951(11), (12); 1954(21); 1955(17); 1958(24); 1960(42).
7	N	1953(C-4); 1957(24); 1960(22).	21	Sc	1935(2); 1936(3), (4); 1958(24), (C-14).
8	O	1953(C-4); 1956(8); 1960(29).	22	Ti	1935(2); 1936(2), (3), (4); 1954(3), (4), (5), (21); 1955(35); 1956(21), (25); 1957(40), (41); 1958(22), (36), (C-14); 1959(39), (40), (41); 1960(7), (9), (30), (44), (45), (46), (C-17).
9	F	1960(29), (30), (44).	23	V	1935(2); 1936(3), (4); 1957(2), (22); 1958(24), (C-14); 1959(42), (C-8); 1960(7), (35), (41), (53).
10	Ne	1955(20); 1959(C-8); 1960(16).	24	Cr	1935(2); 1936(4); 1952(15), (19); 1953(7), (9); 1954(21); 1955(15), (17), (28), (33); 1956(13), (15); 1957(1), (10), (13), (22), (23), (37), (42); 1958(3), (24), (20), (C-12), (C-24); 1959(5), (7), (27), (C-3); 1960(2), (3), (6), (7), (19), (33), (34), (36), (46).
11	Na	1940(5); 1941(2), (3); 1954(13), (C-7); 1955(14), (17), (38); 1956(8); 1958(10), (C-2), (C-3); 1960(18), (30), (44).	25	Mn	1935(2); 1936(4); 1948(1); 1950(6); 1952(19); 1953(7); 1954(11), (21); 1955(16), (28), (29), (37); 1956(13), (17), (25); 1957(22), (33), (42); 1958(1), (15), (16), (24); 1959(23), (C-8); 1960(32), (C-11).
12	Mg	1934(1); 1937(1); 1940(5); 1941(2), (3); 1942(1); 1950(1), (4); 1952(C-1); 1953(18); 1954(6), (C-7); 1955(10), (17), (34); 1956(11), (20); 1957(6), (C-13); 1958(7), (10), (24); 1959(9), (10); 1960(12), (18).	26	Fe	1935(2); 1936(4); 1948(17); 1949(3); 1950(3), (4), (6); 1952(19); 1953(7); 1954(5), (11), (21); 1955(15), (17), (28), (29); 1956(3), (13), (15), (23), (24), (C-8); 1957(13), (22), (23), (37), (42), (C-8); 1958(3), (4), (24), (C-11), (C-12), (C-24); 1959(1), (2), (5), (6), (8), (20), (27), (26), (37), (38), (C-2), (C-3), (C-29), (C-30); 1960(3), (6), (7), (8), (16), (20), (34), (41), (46), (48), (C-11), (C-16).
13	Al	1934(1); 1936(8); 1938(1); 1939(3); 1940(5); 1941(2), (3); 1950(1), (4); 1951(18); 1952(4), (5), (24); 1953(4), (C-4); 1954(6), (13), (19), (C-7); 1955(2), (9), (10), (17), (23), (29), (34); 1956(8), (10), (11), (19), (20), (22), (C-1), (C-8), (C-11); 1957(22); 1958(4), (10), (15), (24); 1959(C-27); 1960(12), (18), (38), (44), (C-6), (C-7), (C-16), (C-19), (S-1), (S-2), (S-3).	27	Co	1935(2); 1936(4); 1939(1); 1950(7); 1954(6), (21); 1955(15), (28); 1956(13); 1957(37), (42); 1958(25), (C-24); 1959(14), (27); 1960(7), (34).
14	Si	1940(5); 1950(4); 1954(2); 1955(10), (33), (37); 1956(1), (8); 1958(24), (C-4), (C-18); 1960(21), (36), (53).			
15	P	1940(5); 1955(33); 1957(19); 1958(24).			
16	S	1935(2); 1936(3), (4); 1940(5); 1948(2); 1951(20); 1952(12); 1954(9); 1955(33); 1958(24); 1960(33), (42).			

# INDEX OF ELEMENTS (Cont'd)

Atomic No.	Element	Papers	Atomic No.	Element	Papers
28	Ni	1935(2); 1936(4); 1937(1); 1939(1); 1940(1), (3); 1949(1), (2), (5); 1950(2), (6), (8), (13), (14); 1951(13), (c-1); 1952(19), (c-5); 1953(3), (7), (c-4); 1954(11), (21); 1955(2), (16), (17), (28), (29), (33), (c-3); 1956(13), (24), (c-1), (c-8); 1957(16), (22), (37), (c-11); 1958(13), (24), (35), (c-22), (c-24); 1959(1), (2), (4), (14), (19), (22), (23), (24), (27), (c-3), (c-30); 1960(7), (13), (31), (34), (37), (42), (43).	40	Zr	1929(1); 1933(1); 1936(1); 1951(9); 1952(14); 1953(c-5); 1954(c-8); 1955(17); 1956(21); 1958(24); 1960(26).
29	Cu	1935(2), (c-1); 1936(4), (8); 1937(1); 1938(1); 1939(1), (5); 1940(2), (3); 1941(1); 1949(1), (2), (3); 1950(2), (6), (8), (14); 1952(15), (21); 1953(3), (7), (10), (c-4), (c-7); 1954(5), (16), (20), (21); 1955(6), (8), (17), (27), (28), (29); 1956(6), (7), (17), (18), (26), (c-8); 1957(16), (25), (35), (37), (39), (c-8), (c-11), (c-12); 1958(10), (12), (13), (15), (16), (17), (24), (28), (30), (31), (c-24); 1959(3), (4), (19), (31), (33), (c-2), (c-20), (c-29); 1960(7), (13), (24), (27), (34), (42), (44), (45), (c-3), (c-6).	41	Nb	1929(1); 1936(1); 1951(9); 1952(14); 1954(c-8); 1957(24); 1958(24); 1960(17), (22), (23).
30	Zn	1936(1), (4), (7); 1939(1), (3); 1940(1), (2); 1941(1); 1949(1); 1950(6); 1951(10); 1953(10); 1955(6), (17), (21), (28); 1957(3), (10), (35), (37), (c-11); 1958(6), (14), (24), (33); 1959(c-20); 1960(3), (25), (27), (34), (38), (48).	42	Mo	1929(1); 1933(1); 1936(1); 1940(4); 1951(9); 1952(2), (14); 1953(12), (c-5); 1954(5), (17), (c-5), (c-8); 1956(23); 1957(5); 1958(24), (28); 1959(7), (12), (36); 1960(17), (23).
31	Ga	1936(1), (4), (7); 1939(1); 1949(1); 1951(10); 1957(19), (37); 1958(22); 1959(c-20); 1960(27).	44	Ru	1929(1); 1933(1); 1936(1), (7); 1940(4); 1951(9); 1952(14); 1958(24).
32	Ge	1936(1), (4), (7); 1939(1); 1950(6); 1951(7), (10); 1954(c-4); 1955(33); 1956(1); 1957(14), (18), (37); 1958(9), (24), (c-4); 1959(25), (34), (c-20); 1960(3), (27), (47), (c-19).	45	Rh	1929(1); 1933(1); 1936(1), (7); 1940(4); 1951(19); 1952(14); 1953(c-5); 1954(c-8); 1958(13), (24); 1960(13), (23).
33	As	1936(1); 1949(1); 1951(10); 1958(24).	46	Pd	1929(1); 1933(1); 1936(1), (7); 1940(4); 1951(9); 1952(14); 1953(c-5); 1954(c-8); 1955(18); 1957(27); 1958(24); 1959(c-20); 1960(13), (23), (32).
34	Se	1936(1); 1951(10); 1958(23), (24); 1959(15), (c-20); 1960(33).	47	Ag	1929(1); 1933(1); 1935(1); 1936(1), (5); 1939(2), (6); 1940(4); 1951(9), (13); 1952(6), (14); 1953(c-3), (c-5); 1954(c-8); 1955(17), (19), (c-6); 1956(c-1); 1957(11); 1958(24), (32), (c-13); 1959(c-16), (c-20), (c-27); 1960(13), (23), (c-19).
35	Br	1936(1); 1951(10); 1958(24), (32); 1960(3), (30).	48	Cd	1929(1); 1935(1); 1936(1); 1940(4); 1951(9); 1952(14); 1953(c-5); 1954(c-8); 1958(24); 1959(28), (c-20), (c-27); 1960(c-19).
36	Kr	1951(10); 1955(c-6); 1957(29); 1958(24); 1959(34).	49	In	1929(1); 1935(1); 1940(4); 1951(9); 1952(14); 1955(17); 1958(24); 1959(c-20), (c-27); 1960(c-19).
37	Rb	1929(1); 1936(1); 1949(1); 1951(9); 1952(14); 1958(24), (c-2); 1959(29).	50	Sn	1929(1); 1931(1); 1935(1); 1940(4); 1951(9); 1952(14); 1953(c-5); 1954(c-8); 1955(2), (17); 1957(15), (c-6); 1958(24), (28); 1959(7), (22), (c-20), (c-27); 1960(c-19).
38	Sr	1929(1); 1936(1); 1951(9); 1952(14); 1953(c-5); 1958(24); 1960(30).	51	Sb	1931(1); 1935(1); 1940(4); 1952(20); 1957(19); 1958(24); 1959(c-20); 1960(33), (c-19).
39	Y	1929(1); 1936(1); 1951(9); 1952(14); 1958(24).	52	Te	1931(1); 1935(1); 1940(4); 1953(6); 1955(39); 1958(24); 1959(c-5), (c-20); 1960(33), (c-19).
			53	I	1940(4); 1957(36); 1958(22); 1960(30).
			55	Cs	1940(4); 1957(36), (c-5); 1958(24), (c-2); 1959(29); 1960(30).
			56	Ba	1931(1); 1940(4); 1953(c-4); 1958(24).

# INDEX OF ELEMENTS (Cont'd)

Atomic No.	Element	Papers	Atomic No.	Element	Papers
58	Ce	1931(1); 1953(2); 1958(19), (24), (34); 1959(c-4); 1960(4).	75	Re	1933(2); 1952(7); 1954(6), (10); 1955(4), (11); 1958(24); 1959(14).
59	Pr	1952(26); 1953(2); 1959(23), (c-4); 1960(4).	76	Os	1933(2); 1952(7); 1954(10); 1955(4), (11); 1958(24).
60	Nd	1931(1); 1952(26); 1953(2); 1958(22), (24); 1959(c-4); 1960(4).	77	Ir	1932(1); 1933(2); 1942(2); 1952(7); 1954(10); 1955(4), (11); 1958(24).
62	Sm	1952(26); 1953(2); 1956(9); 1958(22), (24); 1959(c-4); 1960(4).	78	Pt	1932(1); 1933(2); 1939(4); 1942(2); 1950(5); 1951(3), (13); 1952(7), (10), (17); 1953(17), (c-4); 1954(10); 1955(4), (11), (c-4); 1958(8), (13), (24), (26); 1959(13), (14), (c-11); 1960(30), (40).
63	Eu	1952(26); 1953(2), (13), (14); 1955(25), (26); 1958(24), (27); 1959(c-4); 1960(4).	79	Au	1933(2); 1936(5); 1939(5); 1942(2); 1951(16); 1952(7), (17); 1954(10); 1955(4), (11), (17), (18), (19); 1956(c-1); 1957(27); 1958(8), (13), (24); 1959(14), (c-27); 1960(32), (c-3), (c-19).
64	Gd	1953(2), (13), (15); 1955(25), (26); 1958(22), (24), (25); 1959(c-4); 1960(4).	80	Hg	1933(2); 1942(2); 1949(4); 1951(2); 1952(7), (9), (10); 1954(10); 1955(4), (11); 1958(2); 1959(c-1).
65	Tb	1953(2), (13), (14); 1955(25), (26); 1958(22), (24), (27); 1959(c-4); 1960(4).	81	Tl	1933(2); 1942(2); 1952(7), (17); 1954(8), (10); 1955(4), (11).
66	Dy	1953(2); 1958(22), (24); 1959(c-4); 1960(4).	82	Pb	1933(2); 1942(2); 1952(7), (17); 1954(10), (c-5); 1955(4), (11), (17), (c-4); 1957(15), (26), (c-11).
67	Ho	1953(2), (13), (16); 1955(25), (26); 1958(22), (24), (27); 1959(c-4); 1960(4).	83	Bi	1933(2); 1942(2); 1952(7), (17); 1954(10); 1955(4), (11), (c-4); 1959(c-27); 1960(c-19).
68	Er	1951(17); 1953(2); 1954(18); 1958(22), (24), (26), (27); 1959(c-4); 1960(4).	90	Th	1933(2); 1942(2); 1952(7), (17); 1954(10); 1955(3), (4), (11); 1956(21); 1957(c-9).
69	Tm	1953(2), (13), (15); 1955(25), (26); 1958(22), (24), (27); 1959(c-4); 1960(4).	92	U	1933(2); 1942(2); 1951(3); 1952(7), (17); 1953(12); 1954(6), (10), (c-5); 1955(4), (11); 1956(c-5); 1957(c-9); 1958(18); 1959(c-21).
70	Yb	1953(2); 1958(22), (24); 1959(c-4); 1960(4).	93	Np	1957(17).
71	Lu	1953(2); 1958(22), (24); 1959(c-4); 1960(4).	94	Pu	1954(7); 1956(5); 1957(c-9); 1958(18).
72	Hf	1956(21); 1958(24).			
73	Ta	1932(1); 1933(2); 1952(7), (11); 1953(17); 1954(10); 1955(4), (11); 1958(24); 1960(c-6).			
74	W	1932(1); 1933(2); 1939(4); 1951(2); 1952(7); 1953(6), (17); 1954(8), (10), (17); 1955(4), (11), (17), (36), (c-14); 1957(c-8); 1958(24); 1959(c-16); 1960(28), (30), (31), (43).			

## EMISSION SPECTRA INDEX

## K-SPECTRA:

<u>Element</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
Ag	1951(9); 1952(14), (C-2).	Cu in Cu-Mn	1956(17); 1958(15).
Al	1950(4); 1953(4); 1955(23); 1956(19), (20).	Cu in Cu-Mn-Al	1958(15).
Al in Al-Cu	1936(8); 1938(1).	Cu in Cu-Zn	1940(2).
Al in Al-O	1950(4); 1956(19).	Dy	1958(22).
As	1951(10).	Er	1958(22).
Au	1955(4).	F	1960(30).
B	1940(6); 1960(28).	F in K-F	1940(4).
B in BN	1940(4).	F in Li-F	1940(4).
Be	1934(1); 1940(6); 1959(9); 1960(16), (28).	F in Na-F	1940(4).
Be in Be-Al	1938(1).	F in Mg-F	1940(4).
Be in Be-Cu	1938(1).	Fe	1950(6); 1954(5); 1957(C-8); 1958(3); 1959(5).
Bi	1955(C-4).	Fe in Fe-Cr	1956(15); 1957(13); 1958(3); 1959(5).
Br	1951(10).	Fe in Cr-Ni	1959(5); 1960(6).
Br in LiBr	1940(4).	Ga	1951(10).
Br in KBr	1940(4).	Ge	1950(7); 1951(10); 1956(1).
Br in RbBr	1940(4).	Gd	1958(22).
Br in AgBr	1940(4).	Hg	1951(2); 1955(4); 1958(2); 1959(C-4).
C	1960(17).	I in CsI	1940(4).
Cb	(See Nb).	In	1951(9); 1952(14), (C-2).
Cd	1951(9); 1952(14), (C-2).	Ir	1955(4).
Cl in K-Cl	1940(4); 1951(14); 1954(15); 1955 (24); 1957(34); 1959(30).	K in K-Br	1956(16).
Cl in Li-Cl	1940(4).	K in C-O-K	1956(16).
Cl in Rb-Cl	1940(4).	K in Cl-K	1951(14); 1954(15); 1955(24); 1956(16); 1957(34); 1959(30).
Cl in Cs-Cl	1940(4).	K in I-K	1956(16).
Cl in Ba-Cl	1940(4).	K in K-S	1956(16).
Co	1950(6).	Kr	1951(10).
Cr	1958(3); 1959(5); 1960(19).	Li	1934(1); 1940(6); 1956(20); 1957 (7); 1958(33); 1959(9); 1960(11), (12).
Cr in Cr-Fe	1956(14); 1957(13); 1958(3); 1959(5).	Li in Li-Mg	1959(9); 1960(12).
Cr in Fe-Ni	1959(5); 1960(6).	Lu	1958(22).
Cu	1950(6); 1951(9); 1952(14), (C-7); 1957(C-8).	Mg	1950(4); 1956(20); 1959(9), (10).



## EMISSION SPECTRA INDEX (Cont'd)

## K-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
Mg in Mg-Li	1959(9); 1960(12).	Re	1955(4).
Mg in O-Mg	1950(4); 1959(10).	Rh	1951(9); 1952(14), (C-2).
Mg in S-Mg	1950(4).	Ru	1951(9); 1952(14), (C-2).
Mn	1950(6).	S	1954(9).
Mn in Mn-Cu	1958(15).	S in S-Ca	1954(9).
Mn in Mn-Cu-Al	1958(15).	S in Ca-O-S	1954(9).
Mn in Mn-Ni	1955(16); 1959(22).	S in K-O-S	1954(9); 1956(13).
Mo	1951(9); 1952(14), (C-2); 1953(12); 1954(5).	S in Cu-S	1940(4).
N in BN	1940(4)	S in Mn-S	1954(9).
Nb	1951(9); 1952(14), (C-2).	S in Zn-S	1940(4).
Nd	1958(22).	S in Sr-S	1954(9).
Ne	1955(20).	Se	1949(4); 1951(10).
Ni	1950(6); 1959(5), (24).	Si	1950(4); 1960(21).
Ni in Ni-Mn	1955(16).	Si in Si-C	1950(4); 1960(21).
Ni in Zn-Ni	1940(1), (3).	Si in O-Si	1950(4); 1960(21).
O	1960(29).	Sm	1958(22).
O in O-Be	1940(4).	Sn	1951(9); 1952(14), (C-2).
O in O-Li	1940(4).	Sr	1951(9); 1952(14), (C-2).
O in O-B	1940(4).	Ta	1955(4).
O in O-Mg	1940(4).	Tb	1958(22).
O in O-Al	1940(4).	Th	1955(4).
O in O-Si	1940(4).	Ti	1954(5); 1959(39).
O in O-Ca	1940(4).	Ti in Ti-C	1959(32).
O in O-Fe	1940(4).	Ti in Ti-H	1959(32).
O in O-Zn	1940(4).	Ti in Ti-N	1959(32).
O in O-Sr	1940(4).	Tl	1955(4).
O in O-Ba	1940(4).	Tm	1958(22).
Os	1955(4).	U	1955(4).
Po	1955(4), (C-4).	W	1939(3); 1955(4); 1957(C-8).
Pd	1951(9); 1952(14), (C-2).	Y	1951(9); 1952(14), (C-2).
Pt	1939(3); 1955(4), (C-4).	Yb	1958(22).
Rb	1951(9); 1952(14), (C-2).	Zn	1950(6); 1951(10).
		Zn in Zn-Cu	1940(2).



## EMISSION SPECTRA INDEX (Cont'd)

## K-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>
Zn in Ni-Zn	1940(1), (3).
Zr	1951(9); 1952(14), (C-2).
K SHELL SATELLITES ONLY:	
<u>Element</u>	<u>Papers</u>
As	1936(7); 1955(C-1).
Be	1959(9).
Br	1936(7); 1955(C-1).
Ca	1935(2); 1936(2), (3), (4); 1955(C-1).
Cb	(See Nb).
Cl	1935(2); 1936(3), (4).
Co	1935(2); 1936(4); 1955(28), (C-1).
Cr	1935(2); 1936(4); 1953(9); 1955(28), (C-1); 1957(38).
Cu	1935(2); 1936(4); 1955(28), (C-1).
Fe	1935(2); 1936(4); 1955(28), (C-1); 1957(38); 1960(15).
Ga	1936(4), (7); 1955(C-1).
Ge	1936(4), (7); 1955(C-1).
K	1935(2); 1936(3), (4), (6); 1955(C-1).
Li	1959(9).
Mg	1942(1).
Mn	1935(2); 1936(4); 1955(28), (C-1).
Mo	1936(7); 1955(C-1).
Nb	1936(7); 1955(C-1).
Ne	1960(15).
Ni	1935(2); 1936(4); 1955(28), (C-1).
Pd	1936(7).
Rb	1936(7); 1955(C-1).
Rh	1936(7).
Ru	1936(7).
S	1935(2); 1936(3), (4).
Se	1936(7); 1949(4); 1955(C-1).
Sr	1936(7); 1955(C-1).

ElementPapers

Ti	1935(2); 1936(2), (3), (4); 1955(C-1).
V	1935(2); 1936(3), (4); 1955(C-1).
Y	1936(7); 1955(C-1).
Zr	1936(7); 1955(C-1).

## L-SPECTRA:

ElementPapers

Ag	1952(6).
Al	1934(1); 1940(6); 1941(2); 1952(24); 1955(9); 1956(20), (22); 1960(12), (S-2), (S-3).
Al in Al-Cu	1955(29).
Al in Mg-Al	1955(10); 1956(11).
Al in Si-Al	1955(10).
Au	1951(16); 1960(32).
B	1940(6).
B in BN	1940(4).
Bi	1955(C-4).
Br in Li-Br	1940(4).
Br in K-Br	1940(4).
Br in Rb-Br	1940(4).
Br in Ag-Br	1940(4).
C	1940(6).
Ca	1951(11), (12); 1954(21).
Ca in Ca-O	1954(21).
Cb	(See Nb).
Cl in Li-Cl	1940(4).
Cl in K-Cl	1940(4).
Cl in Rb-Cl	1940(4).
Cl in Cs-Cl	1940(4).
Cl in Ba-Cl	1940(4).
Co	1954(21).
Cr	1954(21).
Cr in Cr-O	1954(21).
Cu	1953(3), (10); 1954(21); 1955(29); 1957(16), (35); 1958(14); 1959(30).

## EMISSION SPECTRA INDEX (Cont'd)

## L-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>
Cu in Cu-Al	1955(29); 1957(25).
Cu in Ni	1957(25).
Cu in O-Cu	1959(3).
Cu in Zn-Cu	1953(10); 1957(25); 1959(30).
Er	1954(18); 1958(24).
Eu	1953(13), (14).
Eu in Eu-O	1955(25), (26).
F in Li-F	1940(4).
F in Na-F	1940(4).
F in K-F	1940(4).
F in F-Mg	1940(4).
Fe	1954(21); 1955(29).
Fe in Fe-Al	1950(4).
Ga	1960(27).
Gd	1953(13), (15).
Gd in Gd-O	1955(25), (26).
Ge	1956(1); 1957(14); 1959(25); 1960(26).
Ge in Ge-O	1957(14).
Ho	1953(13), (16).
Ho in Ho-O	1955(25), (26).
Hg	1949(4).
I in I-Cs	1940(4).
Ir	1932(1).
K	1951(11), (12); 1960(10).
Kr	1957(29).
Li	1956(20).
Li in Li-Mg	1960(12).
Mg	1934(1); 1940(6); 1941(2); 1956(20); 1958(7); 1960(12).
Mg in Mg-Al	1955(10); 1956(11).
Mg in Li-Mg	1960(12).
Mg in Si-Mg	1955(10).
Mn	1954(21); 1955(29).

<u>Element</u>	<u>Papers</u>
Mn in Mn-O	1954(21).
Mo	1959(12).
N in B-N	1940(4).
Na	1940(6); 1941(2).
Nb	1957(24); 1960(22).
Nb in Nb-B	1957(24); 1960(22).
Nb in Nb-C	1957(24); 1960(22).
Nb in Nb-N	1957(24); 1960(22).
Ni	1953(3); 1954(21); 1955(29); 1957(16).
O in O-Be	1940(4).
O in O-Li	1940(4).
O in O-B	1940(4).
O in O-Mg	1940(4).
O in O-Al	1940(4).
O in O-Si	1940(4).
O in O-Ca	1940(4).
O in O-Fe	1940(4).
O in O-Zn	1940(4).
O in O-Sr	1940(4).
O in O-Ba	1940(4).
P	1940(6).
Pb	1955(C-4).
Pd	1957(11); 1960(32).
Pt	1932(1); 1950(5); 1955(C-4); 1960(34).
Pu	1954(7); 1956(5); 1958(18).
S	1940(6); 1948(2).
S in Cu-S	1940(4).
S in Zn-S	1940(4).
Si	1940(6).
Si in Si-Al	1955(10).
Si in Mg-Si	1955(10).
Sm	1956(9).

## EMISSION SPECTRA INDEX (Cont'd)

## L-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>
Ta	1932(1).
Tb	1953(13), (14).
Tb in Tb-0	1955(25), (26).
Tl	1954(21).
Tl in Tl-0	1954(21).
Tm	1953(13), (15).
Tm in Tm-0	1955(25), (26).
U	1953(12); 1954(21); 1958(18).
W	1932(1); 1951(2); 1955(C-4).
Zn	1953(10); 1954(21); 1957(35); 1958(14); 1959(31).
Zn in Zn-Cu	1953(10); 1959(31).
Zr	1960(26).
L SHELL SATELLITES ONLY:	
<u>Element</u>	<u>Papers</u>
Ag	1929(1); 1933(1); 1935(1); 1936(1), (5); 1939(2); 1940(5).
As	1936(1).
Au	1933(2); 1951(16); 1954(10); 1955(11).
Ba	1933(1); 1940(5).
Bi	1933(2); 1954(10); 1955(11).
Br	1936(1).
Cb	(See Nb).
Cd	1929(1); 1935(1); 1936(1); 1940(5).
Ce	1933(1).
Co	1955(28).
Cr	1955(28).
Cu	1955(28).
Fe	1955(28).
Ga	1936(1).
Ge	1936(1).
Hg	1933(2); 1952(9), (10); 1954(10); 1955(11).

<u>Element</u>	<u>Papers</u>
I	1933(1); 1940(5).
In	1935(1); 1940(5).
Ir	1933(2); 1954(10); 1955(11).
Mn	1955(28).
Mo	1929(1); 1933(1); 1936(1); 1940(5).
Nb	1929(1); 1936(1).
Nd	1933(1).
Nl	1955(28).
Os	1933(2); 1954(10); 1955(11).
Pb	1933(2); 1954(10); 1955(11).
Pd	1929(1); 1933(1); 1936(1); 1940(5).
Pt	1933(2); 1951(4); 1952(10); 1954(10); 1955(11); 1960(40).
Rb	1929(1); 1936(1).
Re	1933(2); 1954(10); 1955(11).
Rh	1929(1); 1933(1); 1936(1); 1940(5).
Ru	1929(1); 1933(1); 1936(1); 1940(5).
Sb	1933(1); 1935(1); 1940(5).
Se	1936(1).
Sn	1933(1); 1935(1); 1940(5).
Sr	1929(1); 1936(1).
Ta	1933(2); 1954(10); 1955(11).
Te	1933(1); 1935(1); 1940(5).
Th	1933(2); 1954(10); 1955(11).
Tl	1933(2); 1954(10); 1955(11).
U	1933(2); 1954(10); 1955(11).
W	1933(2); 1954(10); 1955(11).
Y	1929(1); 1936(1).
Zn	1936(1); 1955(28).
Zr	1929(1); 1933(1); 1936(1).

## EMISSION SPECTRA INDEX (Cont'd)

## M-SPECTRA:

<u>Element</u>	<u>Papers</u>
Ca	1954(21).
Ca in Ca-O	1954(21).
Cb	(See Nb).
Co	1954(21).
Cr	1952(15); 1953(7); 1954(21); 1957(1).
Cr in Cr-O	1954(21).
Cu	1952(15); 1953(7); 1954(20, (21); 1955(29).
Cu in Cu-Al	1955(29).
Fe	1953(7); 1954(11), (21); 1955(29).
Ge	1956(1).
K	1960(10).
Mn	1953(7); 1954(11), (21); 1955(29).
Mn in Mn-O	1954(21).
Mo	1954(17); 1960(17).
Nb	1960(17).
Ni	1953(7); 1954(11), (21); 1955(29); 1960(13).
Ti	1954(21).
Ti in Ti-O	1954(21).
U	1954(21).

## M SHELL SATELLITES ONLY:

<u>Element</u>	<u>Papers</u>
Au	1936(5); 1952(17).
Bi	1942(2); 1952(17).
Hg	1942(2).
Ir	1942(2).
Pb	1942(2); 1952(17).
Pt	1942(2); 1952(17).
Th	1942(2); 1952(17).
Tl	1942(2); 1952(17).
U	1942(2); 1952(17).

## N-SPECTRA:

<u>Element</u>	<u>Papers</u>
Ag	1960(13).
Pd	1960(13).
Rh	1960(13).
W	1954(17).

# ABSORPTION SPECTRA INDEX

## K-SPECTRA:

<u>Element</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
A	1959(34).	Cr in Cr-O	1958(20); 1960(34).
Al	1952(4), (5); 1956(10), (C-11).	Cr in Cr-S	1960(33), (34).
Al in Al-Cu	1950(1).	Cr in Cr-Sb	1960(33).
Al in Al-Mg	1950(1).	Cr in Cr-Se	1960(33).
Al in Al-Mg-Si	1950(1).	Cr in Cr-Si	1960(36).
Al in Al-Zn	1960(38).	Cr in Cr-Te	1960(33).
As	1949(1).	Cs in Cs-Cl	1958(21); 1959(29).
As in As-Ga	1957(19).	Cu	1939(1); 1949(2), (3); 1950(8); 1958(17); 1960(7), (34), (42).
As in As-In	1957(19).	Cu in Cu-Al-Mn	1958(16).
As in As-Ni	1949(1).	Cu in Cu-Ni	1950(14); 1958(17).
B	1951(6).	Cu in Cu-O	1949(1); 1958(17); 1960(34).
Be	1951(6); 1954(12); 1955(33); 1956(C-11).	Cu in Cu-S	1960(34), (42).
Be in Be-O	1955(33).	Cu in Cu-Zn	1940(2); 1955(6); 1958(17).
C	1951(6); 1955(9).	Fe	1939(1); 1948(1); 1949(3); 1956(24); 1959(8), (26); 1960(7), (8), (34).
Cl in Cl-Cs	1957(3), (4); 1959(29).	Fe in Fe-Al	1960(34).
Cl in Cl-H	1951(20).	Fe in Fe-Co	1959(27).
Cl in Cl-K	1955(14), (24); 1957(3), (4), (34).	Fe in Fe-Cr	1956(13); 1957(23); 1959(27).
Cl in Cl-Li	1957(3), (4); 1959(29).	Fe in Fe-Mo	1956(23).
Cl in Cl-Na	1955(14); 1957(3).	Fe in Fe-Ni	1959(1), (2), (27).
Cl in Cl-Rb	1957(3), (4); 1959(29).	Fe in Fe-O	1950(3); 1959(38); 1960(34).
Co	1939(1); 1960(7), (34).	Fe in Fe-Pt	1960(20).
Co in Co-Cr	1956(13).	Fe in Fe-S	1960(34), (41).
Co in Co-Fe	1959(27).	Ga	1939(1); 1949(1).
Co in Co-O	1960(34).	Ga in Ga-As	1957(19).
Co in Co-S	1960(34).	Ga in Ga-P	1957(19).
Cr	1955(33); 1958(20); 1959(7); 1960(7), (34).	Ga in Ga-Sb	1957(19).
Cr in Cr-B	1958(20).	Ge	1939(1); 1955(33); 1957(18); 1958(9); 1960(47).
Cr in Cr-C	1958(20).	Ge in Ge-Br	1951(7).
Cr in Cr-Co	1956(13).	Ge in Ge-Cl	1951(7).
Cr in Cr-Fe	1956(13); 1957(23); 1959(27).	Ge in Ge-H	1957(7).
Cr in Cr-Mo	1959(7).	K in K-Br	1952(18); 1955(35); 1957 (3), (30).
Cr in Cr-N	1958(20).		



ABSORPTION SPECTRA INDEX (Cont'd)

K-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
K in K-Cl	1952(18); 1955(14), (24), (35); 1957(3), (4), (30), (34).	S	1955(33); 1960(42).
K in K-F	1952(18); 1955(35); 1957(3), (30).	S in S-C	1951(20).
K in K-I	1952(18); 1955(35); 1957(3), (30).	S in S-H	1951(20).
Kr	1959(34).	S in S-O	1951(20).
Li	1937(1); 1950(9); 1952(13).	Sb	1952(20).
Li in Li-Cl	1959(29).	Sb in Sb-Ga	1957(19).
Mg	1957(6).	Se	1959(15).
Mg in Mg-Al-Si	1950(1).	Si	1955(33).
Mn	1948(1); 1955(33); 1960(34).	Si in Si-O	1955(33).
Mn in Mn-Al-Cu	1958(16).	Sn in Sn-Pb	1959(7).
Mn in Mn-Ni	1956(13); 1959(23).	Ti	1956(25); 1960(7).
Mn in Mn-O	1960(34).	Ti in Ti-B	1959(40), (41).
Mn in Mn-S	1960(34).	Ti in Ti-Ba-O	1954(3), (4); 1958(36); 1960(9).
Mo in Mo-Cr	1959(7).	Ti in Ti-C	1957(40), (41); 1958(37); 1959(41).
Na in Na-Cl	1955(14).	Ti in Ti-C-W	1957(40).
Ni	1939(1); 1940(3); 1949(1), (2); 1950(2), (8), (13); 1955(33); 1956 (24); 1959(24); 1960(7), (34), (42).	Ti in Ti-Ca-O	1958(34).
Ni in Ni-Al	1960(37).	Ti in Ti-Fe-O	1958(36).
Ni in Ni-As	1949(1).	Ti in Ti-H	1957(40); 1959(40), (41).
Ni in Ni-Cl	1949(5).	Ti in Ti-Mg-O	1958(36).
Ni in Ni-Cu	1950(2), (14).	Ti in Ti-N	1957(40); 1959(41).
Ni in Ni-Fe	1959(1), (2), (27).	Ti in Ti-O-Pb	1954(3), (4).
Ni in Ni-Mn	1956(13).	Ti in Ti-O-Sr	1958(36).
Ni in Ni-O	1949(1); 1950(2), (13); 1958(35); 1960(34).	Ti in Ti-O	1954(3); 1955(36); 1956(25); 1957(40); 1958(37).
Ni in Ni-O-S	1949(5); 1950(13).	Ti in Ti-O-Zn	1958(36).
Ni in Ni-S	1949(1); 1950(13); 1960(34), (42).	Ti in Ti-Si	1959(40).
Ni in Ni-Zn	1940(1), (3).	V	1960(7), (35).
P	1955(33).	V in V-B	1959(42).
P in P-Ga	1957(19).	V in V-C	1959(42).
Pb in Pb-Sn	1959(7).	V in V-Fe	1960(41).
Pd	1957(27).	V in V-H	1959(42); 1960(35).
Pd in Pd-Au	1957(27).	V in V-N	1959(42).
		V in V-Sn	1960(53).
		Zn	1939(1); 1940(3); 1960(34).

# ABSORPTION SPECTRA INDEX (Cont'd)

## K-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
Zn in Zn-Al	1960(38).	Cs in Cs-F	1957(36).
Zn in Zn-Cu	1940(2); 1941(1); 1956(7).	Cs in Cs-I	1957(36).
Zn in Zn-Ni	1940(1), (3).	Cu	1953(3); 1957(16); 1958(17).
Zn in Zn-O	1949(1); 1960(34).	Cu in Cu-Al	1958(17); 1960(27).
Zn in Zn-S	1957(19); 1960(34).	Cu in Cu-Ni	1958(17); 1960(27).
		Cu in Cu-O	1958(17); 1959(3).
		Cu in Cu-Zn	1958(17); 1960(27).

## K-ABSORPTION SPECTRA OF ELEMENTS IN COMPLEXES:

<u>Element and Complex</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
Co in $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ ; $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ ; $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	1958(25).	Er	1954(18).
Co in various salts	1957(42); 1959(14).	Er in Er-O	1958(27).
Cr in cyano and carbonyl salts	1957(10).	Eu	1953(14).
Cr in $\text{Cr}_2(\text{SO}_4)_3$	1958(20).	Eu in Eu-O	1958(27).
Cr in various salts	1952(19); 1957(42).	Ga	1960(27).
Cu in $\text{Cu}(\text{H}_2\text{O})_6^{++}$	1956(7).	Gd	1953(15).
Cu in cyano and carbonyl salts	1957(10).	Gd in Gd-O	1958(27).
Cu in various salts	1956(7).	Ge	1955(33); 1959(25); 1960(27).
Fe in various salts	1952(19); 1957(42).	Ho	1953(16).
Mn in various salts	1952(19); 1957(42).	Ho in Ho-O	1958(27).
Ni in various salts	1952(19); 1959(14).	I in I-Cs	1957(36).
$\text{Zn}^{++}$ in various salts	1958(6).	I in I-K	1957(36).
		I in I-Li	1957(36).
		I in Na-I	1957(36).
		I in Rb-I	1957(36).

## L-SPECTRA:

<u>Element</u>	<u>Papers</u>	<u>Element</u>	<u>Papers</u>
Al	1939(3); 1951(18); 1960(39), (S-1), (S-3).	Mg	1937(1).
Au	1939(5); 1955(18), (19); 1960(32).	Mn	1955(33).
Au in Au-Ag	1955(19).	Mo	1959(12), (36).
Au in Au-Pd	1955(18); 1960(32).	Mo in Mo-C	1957(5).
Be	1955(33).	Mo in Mo-O	1957(5).
Ce in Ce-Al	1958(19).	Mo in Mo-S	1957(5).
Ce in Ce-B	1958(34).	Ni	1953(3); 1955(33); 1957(16).
Ce in Ce-O	1958(34).	Np	1957(17).
Cr	1955(33).	P	1955(33).
Cs in Cs-Br	1957(36).	Pb in Pb-O	1957(15).
Cs in Cs-Cl	1957(36).	Pb in Pb-Sn	1957(15).
		Re in Re-O	1954(6).

# ABSORPTION SPECTRA INDEX (Cont'd)

## L-SPECTRA (Cont'd)

<u>Element</u>	<u>Papers</u>
S	1955(33).
Se	1958(23).
Se in Se-O	1958(23).
Si	1954(2); 1955(33); 1956(1).
Si in Si-O	1954(2).
Tb	1953(14).
Tm	1953(15).
Tm in Tm-O	1958(27).
U in U-O	1951(3); 1954(6).
Zn	1939(3); 1960(27).
Zr	1960(26).

## L-ABSORPTION SPECTRA OF ELEMENTS IN COMPLEXES:

<u>Element and Complex</u>	<u>Paper</u>
Au (NaAuCl <sub>4</sub> ; KAuCl <sub>4</sub> )	1958(8).
Au	1959(14).
Mo in (NH <sub>4</sub> ) <sub>2</sub> MoO <sub>4</sub> ; K <sub>4</sub> Mo(CN) <sub>8</sub>	1952(2).
Pt in K <sub>2</sub> Pt(CN) <sub>6</sub> ; K <sub>2</sub> PtCl <sub>3</sub>	1958(8).
Pr (20 salts)	1959(13), (14).
Re (various salts)	1959(14).

## M-SPECTRA:

<u>Element</u>	<u>Papers</u>
Au	1960(32).
Au in Au-Cu	1939(5).
Co	1957(37).
Cr	1955(33); 1957(1), (37); 1960(2).
Cu	1937(1); 1957(37); 1960(39).
Er	1951(17).
Eu	1952(26).
Fe	1956(3); 1957(37).
Fe in Fe-O	1956(3).
Ga	1957(37).
Ge	1955(33); 1956(1); 1957(37).
Mn	1955(33); 1957(37); 1958(1).
Mn in Mn-O	1958(1).
Nd	1952(26).
Ni	1937(1); 1955(33); 1957(37).
Pr	1952(26).
Ta	1952(14).
Th in Th-O	1955(3).
Th in Th-O-N	1955(3).
V	1957(2).
U in U-O	1951(3).
Zn	1957(37).

## N-SPECTRA:

<u>Element</u>	<u>Papers</u>
Te	1955(39).

## SOFT X-RAY ABSORPTION COEFFICIENT STUDIES INDEX

<u>Substances</u>	<u>Spectral Region</u>	<u>Papers</u>
Z = 1-36	5-50 Å	1957(20)
Li	5.5-20 keV	1960(15)
Mg	80-350 Å	1953(18)
Mg	7-24 Å	1957(6)
MgO	80-350 Å	1953(18)
Te	100-400 Å	1955(39)

## ENERGY BAND CALCULATIONS INDEX

<u>Element</u>	<u>Papers</u>
Ag	1960(23).
Al	1954(13); 1958(C-8).
B in B-N	1958(C-7); 1960(C-14).
C	1952(C-4); 1958(C-4), (C-6); 1959(17), (C-15).
Co	1958(C-24).
Cr	1958(C-24); 1959(C-3).
Cr in Cr-Fe	1958(C-12).
Cs	1957(C-5); 1958(C-2).
Cu	1935(C-1); 1958(C-8), (C-24).
Fe	1958(C-11), (C-23); 1959(C-3); 1960(C-11).
Fe in Fe-Cr	1958(C-12).
Ge	1958(C-4).
K	1958(C-2).
Li	1954(13); 1958(C-2).
Mg	1952(C-1).
Mn	1960(C-11).
Mo	1960(23).
Na	1954(13); 1958(C-2), (C-3).
Nb	1960(23).
Ne	1958(C-10).
Ni	1950(C-1); 1952(C-5); 1955(C-3); 1958(C-24); 1959(C-3).
Pd	1960(23).
Pu	1957(C-9).
Rb	1958(C-2).

<u>Element</u>	<u>Papers</u>
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Rh	1960(23).
Sc in Sc-O	1958(C-14).
Te	1959(C-5).
Th	1959(C-9).
Ti in Ti-O	1958(C-14).
V in V-O	1958(C-14).
U	1957(C-9).

## TRANSITION PROBABILITIES FOR SOFT X-RAYS INDEX

<u>Element</u>	<u>Papers</u>
Al	1941(3).
Bi	1955(C-4).
K	1955(C-5).
Mg	1941(3).
Na	1941(3).
Pb	1955(C-4).
Pt	1955(C-4).
W	1955(C-4).

## X-RAY SCREENING CONSTANTS INDEX

<u>Element</u>	<u>Papers</u>
Ca	1960(48).
Cr	1957(22).
Fe	1957(22); 1960(48).
Mn	1957(22).
Na	1957(22).
Ni	1957(22).
V	1957(22).
Zn	1960(48).
Z = 23-92	1956(C-7).

## CRITICAL POTENTIALS FOR SOFT X-RAYS INDEX

<u>Element</u>	<u>Papers</u>
Cu	1953(C-7); 1955(27).
Fe	1959(20).
Li	1950(10).
Ni	1959(22).

# PHOTOELECTRIC PHENOMENA INDEX

## Element                      Papers

Ag                      1960(C-19).

Ag in Ag-Br        1958(32).

Al                      1960(C-19).

Au                      1958(13); 1960(C-19).

Au in Au-Sn        1959(28).

Be                      1960(29).

Bi                      1960(C-19).

Br-Na                1960(30).

C                      1959(32).

Ca-F                 1960(31).

Cd                      1959(28); 1960(C-17).

Cd in Cd-O         1959(28).

Cl-Na                1960(31).

Cr                      1959(32).

Cs in Cs-I           1960(30).

Cs in Cs-Br        1960(C-18).

Cs in Cs-Li         1960(C-18).

Cu                      1958(13), (30), (31); 1959(C-20).

Cu in Cu-O         1958(30), (31).

Dy                      1960(4).

Er                      1960(4).

Eu                      1960(4).

F in F-Li            1960(31).

F in F-Na            1960(31).

F in F-Sr            1960(30), (31).

Ga                      1959(C-20).

Gd                      1960(4).

Ge                      1959(C-20); 1960(C-19).

Hf                      1959(32).

Ho                      1960(4).

I in I-K              1960(C-18).

I in I-Na             1960(C-18).

I in I-Rb             1960(C-18).

In                      1960(C-19).

## Element

## Papers

K in K-I            1960(C-18).

Li in Li-Cs         1960(C-18).

Lu                      1960(4).

Mo                      1959(32).

Na in Na-I          1960(C-18).

Nd                      1960(4).

Ni                      1958(13); 1960(31), (43).

Pt                      1958(13); 1960(30).

Rb in Rb-I          1960(C-18).

Rh                      1958(13).

S                      1959(32).

Sb                      1960(C-19).

Se                      1959(C-20).

Si                      1959(32).

Sm                      1960(4).

Sn                      1959(28); 1960(C-19).

Sn in Sn-Au        1959(28).

Sn in Sn-O          1959(28).

Tb                      1960(4).

Te                      1960(C-19).

Ti                      1959(32); 1960(30), (C-19).

Tm                      1960(4).

U                      1959(C-21).

W                      1959(32); 1960(30), (31), (43).

Yb                      1960(4).

Zn                      1959(C-20).

Zr                      1959(32).



# AUGER PHENOMENA INDEX

# X-RAY SCATTERING STUDIES INDEX

<u>Element</u>	<u>Papers</u>
A	1955(C-6).
Ag	1953(C-3), (C-5); 1954(C-8); 1955(C-6); 1958(C-13).
Al	1953(C-4).
Ba	1953(C-4); 1956(C-10).
Be	1953(C-4).
C	1953(C-4).
Cd	1953(C-5); 1954(C-8).
Cl	1955(C-8).
Cu	1953(C-4); 1957(C-11), (C-12); 1959(33).
Hg	1959(C-1).
Kr	1955(C-6).
Mg	1957(C-13).
Mn	1959(C-8).
Mo	1953(C-5); 1954(C-8).
N	1953(C-4).
Nb	1954(C-8).
Ne	1959(C-8).
Ni	1953(C-4); 1957(C-11); 1958(C-19).
O	1953(C-4).
Pb	1957(C-11).
Pd	1953(C-5); 1954(C-8).
Pt	1953(C-4).
Rh	1953(C-5); 1954(C-8).
Sn	1953(C-5); 1954(C-8); 1957(C-6).
Sr	1953(C-5).
V	1959(C-8).
Zn	1957(C-11).
Zr	1953(C-5); 1954(C-8).

<u>Element</u>	<u>Papers</u>
Al	1956(8).
Co	1958(C-24).
Cr	1958(C-24).
Cu	1958(C-24); 1959(19), (C-2), (C-29).
Fe	1958(C-24); 1959(C-2), (C-20), (C-29).
Na	1956(8).
Ni	1958(C-24); 1959(19), (C-30).
O	1956(8).
Si	1956(8).

## REVIEW

(R-1)  
Boyce, J. C. SPECTROSCOPY IN THE VACUUM  
ULTRAVIOLET.  
Rev. Mod. Phys. 13, 1-57 (1941).

1. This is a review of vacuum ultraviolet and soft X-ray techniques. Numerous references for the period 1893-1940 are given. Subject headings include:  
Transmission of gases and vacuum requirement,  
Transmission of solid materials,  
Reflecting power of gratings and mirrors,  
Photographic techniques and other methods of detection,  
Spectrographic design,  
Light sources,  
Wavelength standards,  
Atomic spectra,  
Molecular spectra,  
Spectra of the solid state,  
Astrophysical and other applications,  
Principal absorption band heads in oxygen and in nitrogen,  
Tables of wavelength standards in the vacuum ultraviolet,  
Bibliography of atomic spectra in the vacuum ultraviolet.

(R-2)  
Cauchois, Y., LES SPECTRES DE RAYONS X ET LA  
STRUCTURE ELECTRONIQUE DE LA MATIERE.  
(In French.)  
Paris, Gauthier-Villars (1948), 102 pp.

(R-3)  
Cauchois, Y., X-RAY SPECTROSCOPY WITH CURVED  
CRYSTALS.  
Instruments & Measurements Conference  
Stockholm, Transactions 1949, 46-59.

1. A general discussion of method and technique using crystal spectrometers is given as is a literature review on Ga, Zn, Br, Cu, Ni, Mo, In, Cd, Sm, Sb, Te.

(R-4)  
Cauchois, Y., ATOMES, SPECTRES MATIERE. (In French.)  
Paris, Albin Michel (1952), 640 pp.

(R-5)  
LANDOLT-BORNSTEIN TABLES (Verlag Springer, Berlin  
1955). Vol. 1, Part 4 (6th edition) 769-867.

1. Experimental data are reproduced, but no explanation or discussion of them is presented.

(R-6)  
M.I.T. SOLID STATE PHYSICS GROUP, QUARTERLY REPORTS.  
M.I.T. Research Laboratory of Electronics;  
published January, April, July, and October.  
Issues of interest and topics are as follows:

<u>Issue</u>	<u>Page</u>	<u>Topic</u>
10-15-50	20	Calibration of vacuum spectrograph.
1-15-51	24	L emission spectrum of Al.
1-15-52	13	Preliminary results on Cr.
4-15-52	13	M <sub>2,3</sub> bands of evaporated Cu.
7-15-52	12	M <sub>2,3</sub> bandwidths of Cu and Cr.

<u>Issue</u>	<u>Page</u>	<u>Topic</u>
10-15-52	10	Preliminary results on the M <sub>2,3</sub> band of Ni.
4-15-53	12	3p emission of Mn.
7-15-53	16	Final results on Cu, Cr, Ni, Mn, and Fe.
1-15-54	9	General description of the apparatus.
7-15-58	3	Magnitude of soft X-ray production and photoelectric emission in Ta, W, and Mo.
4-15-59	13	Focusing properties of a 3π/2 electron spectrometer for studies of photoelectric emission excited by soft X-rays.
7-15-59	44	M-emission bands of Cu and Ni in the solid state.
1-15-60	60	Discussion of M <sub>2,3</sub> emission band results.
1-15-60	62	Soft X-ray detection by means of Be-Cu photomultipliers.
7-15-60	63	Construction of a new photoelectric spectrograph capable of being evacuated to 10 <sup>-10</sup> mm Hg.

(R-7)  
Niehrs, H., RONTGENSPEKTROSKOPIE DER VALENZELEK-  
TRONEN-BANDER IN KRISTALLEN. (In German.)  
Ergeb. exakt. Naturw. 23, 359-409 (1950).

(R-8)  
Parratt, L. G., ELECTRONIC BAND STRUCTURE OF SOLIDS  
BY THE METHOD OF EXPERIMENTAL X-RAY  
SPECTROSCOPY.  
Office of Technical Services, PB151453,  
117 pp. (1958).

1. A discussion of the fundamental aspects of solid state X-ray spectroscopy is presented and correlated insofar as possible with selected experimental work; much emphasis is placed upon data interpretation.  
Note: 76 references are appended.

(R-9)  
Parratt, L. G., ELECTRONIC BAND STRUCTURE OF  
SOLIDS BY X-RAY SPECTROSCOPY.  
Rev. Modern Phys. 31, 616-645 (1959).

1. Pertinent solid state X-ray spectra, terms applicable to X-ray spectroscopy, experimental difficulties, etc., are discussed. Bandwidths are presented. Excited-state energy level diagrams are contrasted with the conventional energy level diagrams and the effects on the observed spectra due to changes in the electron energy level values are discussed.

(R-10)  
Parratt, L. G., ELECTRONIC BAND STRUCTURE OF  
SOLIDS BY X-RAY SPECTROSCOPY.  
Methods of Experimental Physics - Solid State  
Physics B-6, 281-292 (1959).

1. A brief review of the general principles of X-ray spectroscopy is given. For a more complete treatment by the same author see Refs. R-8 and R-9.

(R-11)

Pike, E. R., INTRODUCTION TO SOFT X-RAY SPECTROSCOPY.  
American Journal of Physics 28, 235-242 (1960).

1. A general review in which the experimental methods are outlined and recent trends are detailed.

(R-12)

Sandstrom, A. E., EXPERIMENTAL METHODS OF X-RAY SPECTROSCOPY: ORDINARY WAVELENGTHS.  
Encyclopedia of Physics (Handbuch der Physik) 30, 78-245 (1959).

1. The following tables are presented: wavelength of emission lines from 100 - 20,000 XU,  $K\alpha$  satellites for  $Z = 16-46$ ,  $K\beta$  satellites for  $Z = 14-47$ , wavelengths of K,  $L_1$ ,  $L_2$ , and  $L_3$  absorption edges, fine structure of absorption spectra, relative values of energy levels, line widths at half-maximum for  $Z = 16-42$  and relative line intensities.  
Note: 128 references are appended.

(R-13)

Shaw, C. H. X-RAY SPECTROSCOPY OF SOLIDS.  
Theory of Alloy Phases - Amer. Soc. for Metals 1956, 13-62. Text 13-47,  
Bibliography 48-62.

1. In this review article, containing 353 references, such things as the history of the art, earlier work, satellite production, etc., are discussed; a great many K, L, and M spectra are reproduced from the literature and evaluated.

(R-14)

Shaw, C. H., THE X-RAY SPECTROSCOPY OF SOLIDS.  
U.S. At. Energy Comm. AECU-3190, 75 pp.(1956).

1. See annotation for Ref. R-13.

(R-15)

Skinner, H. W. B., THE SOFT X-RAY SPECTROSCOPY OF THE SOLID STATE.  
Reports on Progress in Physics 5, 257-283 (1939). (The Physical Society, London.)

1. This is a review with 46 references. (See Ref. 6 (1940) for the aspects discussed.)

(R-16)

Tomboulia, D. H., THE EXPERIMENTAL METHODS OF SOFT X-RAY SPECTROSCOPY.  
Encyclopedia of Physics (Handbuch der Physik) 30, 246-304 (1959).

1. Electronic states, emission and absorption processes in solids and such special features as satellite bands, high and low energy tails, emission edges, and insulators are discussed.
2. Experimental methods, and results for many K, L, and M spectra are presented.
3. Tables give bandwidths, absorption edges,

emission edges, and term values.

Note: Thirteen summarized references are appended.

(R-17)

Tsutsumi, K, et al, THE X-RAY SPECTROSCOPY OF THE SOLID STATE.  
Ann. Rept. Sci. Work, Fac. Sci. Osaka U. 7, 1-88 (1959).

1. A general review of the subject is presented.

(R-18)

CONFERENCE ON THE APPLICATIONS OF X-RAY SPECTROSCOPY TO SOLID STATE PROBLEMS.  
Office of Naval Research, NP-4287; NAVEXOS P-1033, 81 pp. (1950).

Papers presented:

- 1) X-ray spectra and the theory of solids.
- 2) X-ray spectroscopy at the University of Paris.
- 3) Fine structure near X-ray absorption edges.
- 4) Energy band calculations for soft X-ray emission.
- 5) Bent crystal vacuum spectrograph and the spectra of KCl.
- 6) Radiative and electronic excitation of X-ray states.
- 7) Absorption of Se and Al in the soft X-ray region.
- 8) X-ray absorption edges of covalently bonded Cr, Mn, Fe, and Ni.
- 9) Crystals for a double crystal spectrometer (3-15A).
- 10) Beaded wire G-M counter for X-ray intensity measurements.

(R-19)

Vainshtein, E. E., (Book) X-RAY SPECTRA OF ATOMS AND MOLECULES IN CHEMICAL COMPOUNDS AND ALLOYS. (In Russian.)  
Acad. Sci. U.S.S.R. Press (1950).

1929

(1)E

Richtmyer, F. K. and R. D. Richtmyer, THE SATELLITES OF THE X-RAY LINES  $L\alpha_1$ ,  $L\beta_1$ , and  $L\beta_2$ .  
Phys. Rev. 34, 574-581 (1929).

1. The  $L\alpha_1$ ,  $L\beta_1$ , and  $L\beta_2$  satellite structure for elements Rb to Sn were studied.
2. A crystal (calcite or quartz) spectrometer was used; intensities were recorded photographically.
3. Tables of  $\lambda$ ,  $\nu/R$ , and  $\Delta\nu/R$  for 5  $L\alpha_1$  satellites, 4  $L\beta_1$  satellites, and 5  $L\beta_2$  satellites are presented.
4. The square root of the difference in frequency between a parent and its satellite is a linear function of atomic number.

1931

(1)E

Richtmyer, R. D., UPPER ATOMIC-NUMBER LIMITS FOR SATELLITES OF THE X-RAY LINE  $L\beta_2$ .  
Phys. Rev. 38, 1802-1807 (1931).

(1)E Cont'd.

1.  $L\beta_2$  satellites in elements of  $Z = 50, 51, 52, 53, 56, 58,$  and  $60$  were studied.
2. A Siegbahn crystal (calcite) spectrometer was used; intensities were recorded photographically.
- 3a. Results are tabulated.
- 3b. The results disagree with the Wentzel-Dryvesteyn formula for the ratio of the number of KL ionizations to the number of K ionizations which should take place.

1932

(1)E

Andrew, V. J., RELATIVE INTENSITIES OF  $L\beta_{1,2}$   $L\alpha_1$ , and  $Ly_1$  LINES IN Ta, W, Ir, and Pr. Phys. Rev. 42, 591-608 (1932).

2. A bent crystal (mica) spectrometer and a  $CH_3Br$  ionization chamber were used to obtain data.
3. Complete tables of results corrected for absorption in the ionization chamber, partial reflection by the crystal, target absorption, and interference from adjacent lines are presented.

(2)T

Hoyt, A., THE SHAPE OF AN X-RAY LINE. Phys. Rev. 40, 477-483 (1932).

- 1,2. An emission line measured in a double crystal spectrometer in the antiparallel position is represented by an empirical formula of the type:

$$y = \frac{a}{1 + (x/b)^2}$$

- 3a. This type of formula is also shown to be a good representation of the rocking curves obtained in the parallel position of the spectrometer.
- 3b. The maximum ordinate predicted is independent of the spontaneous transition probability.

(3)E

Mack, J. E., J. R. Stehn, and B. Edlen. ON THE CONCAVE GRATING SPECTROGRAPH ESPECIALLY AT LARGE ANGLES OF INCIDENCE. J. Opt. Soc. Am. 22, 245-264 (1932).

1. A review covering the physical optics of the perfect concave grating, optimum grating width, elimination of grazing incidence aberrations, and the inexactness of the grating equation is presented.
- 3a. Equations for the optimum grating width, and slit width are given. These can be plotted easily as a function of wavelength.
- 3b. A resolution criterion is given such that two lines are resolved when the wavelength difference between them ( $\Delta\lambda$ ) is such that the minimum total intensity between the lines is  $8/\pi^2$  as great as the total intensity of both at the central maximum of either of the lines.

1933

(1)E

Hirsh, Jr., F. R. and F. K. Richtmyer. THE RELATIVE INTENSITIES OF CERTAIN L-SERIES X-RAY SATELLITES IN CATHODE RAY AND IN FLUORESCENCE EXCITATION. Phys. Rev. 44, 955-960 (1933).

1. The  $L\alpha$  satellites in Zr, Mo, Ru, Rh, Pd, and Ag were studied.
2. A Siegbahn (bent crystal) spectrograph was used; intensities were recorded photographically.
- 3a. The magnitude of the integrated satellite intensity varies from 10-70% of the parent  $L\alpha$  depending upon the element in question.
- 3b. Spectra and tabular data are presented.
4. The peripheral electron structure of the atom has an effect, but the LM ionization is the most probable cause of the observed satellites.

(2)E

Richtmyer, F. K., and S. Kaufman. X-RAY SATELLITES OF HIGH ATOMIC NUMBER ELEMENTS. Phys. Rev. 44, 605-609 (1933).

1. The satellites of the  $L\alpha_1$ ,  $L\beta_2$ , and  $L\alpha_2$  lines for elements from Ta to U were studied.
2. A Siegbahn-Thoraeus (crystal) spectrometer was used; intensities were recorded photographically.
- 3a.  $L\alpha$  was found to have two satellites.
- 3b. The values of  $\lambda$ ,  $\Delta\lambda$ , and  $\Delta\nu/R$  for all satellites observed are tabulated.

1934

(1)T

Jones, H., N. F. Mott, and H. W. B. Skinner, THEORY OF THE FORM OF X-RAY EMISSION BANDS OF METALS. Phys. Rev. 45, 379-384 (1934).

1. Results for Li, Be, Mg, and Al are explained.
3. Transition probabilities from the conduction band to K and L levels may vary strongly within the lowest allowed zone, and they will also depend on the azimuthal quantum number of final states.

1935

(1)E

Hirsh, Jr., F. R. RELATIVE ENERGY OF  $L\alpha$  SATELLITES PRODUCED BY CATHODE RAYS IN ELEMENTS FROM Ag(47) TO Te(52). Phys. Rev. 48, 722-724 (1935).

2. A Siegbahn spectrometer was used; intensities were recorded photographically.
- 3a. From  $Z = 47$  to  $Z = 52$ , the satellites decrease rapidly in relative energy.
- 3b. The results agree with the Coster-Kronig theory.



(1)E Cont'd.

3c. Tables and spectra are presented.

(2)E

Pearsall, A. W. INTENSITIES OF SATELLITES OF  $K\alpha$ .  
Phys. Rev. 48, 133-135 (1935).

1. The intensities relative to that of the parent line for  $K\alpha_1$  satellites of elements with atomic number 16-29 were measured.
2. A Siegbahn spectrograph was used; intensities were recorded photographically.
- 3a. The intensities are lower (0.7% to 5%) than the  $L\beta_2$  satellites (32%).
- 3b. Data are tabulated and the Fe spectrum is presented.
4. An intensity maximum found cannot be explained by the Auger effect.

(C-1)T

Krutter, H. M. ENERGY BANDS IN COPPER.  
Phys. Rev. 48, 664-670 (1935).

- 1,2. A corrected Hartree field is used to calculate the bands in FCC metals using copper as an example.
- 3a. The 3d and 4s band overlap is shown and a correlation of the  $\langle 100 \rangle$ ,  $\langle 110 \rangle$ , and  $\langle 111 \rangle$  direction bands is given.
- 3b. Electrons are assigned to lowest energy bands.

1936

(1)E

Hirsh, Jr., F. R., THE ENHANCEMENT OF CERTAIN L AND M SERIES X-RAY LINES BY THE AUGER EFFECT.  
Phys. Rev. 50, 191-197 (1936).

1. The  $L\beta_1$  lines of elements of  $Z = 30-48$  (5-12A) were studied.
2. A crystal (gypsum) spectrometer was used; intensities were recorded photographically.
- 3a. A large change in relative intensity was observed at  $Z = 40$  due to Auger enhancement.
- 3b. Spectra are presented and all results are tabulated.

(2)E

Parratt, L. G. EXCITATION POTENTIAL OF  $K\alpha_{3,4}$  SATELLITE LINES.  
Phys. Rev. 49, 132-139 (1936).

1. The K satellite intensity vs. X-ray tube voltage for the  $K\alpha_{3,4}$  lines of titanium was determined.
2. A double crystal (calcite) spectrometer was used; intensities were recorded, using ion chamber detection.
- 3a. The excitation potential of the Ti- $K\alpha_{3,4}$  is  $5450 \pm 100$  volts.
- 3b. A state of  $KL_{III}$  ionization is 5455 volts in Ti using 0.85 as the screening constant of a K electron.

(3)E

Parratt, L. G. EXCITATION POTENTIAL, RELATIVE INTENSITIES AND WAVELENGTHS OF THE  $K\alpha''$  X-RAY SATELLITE LINE.  
Phys. Rev. 49, 502-507 (1936).

1. The ionization curves of the  $K\alpha''$  for the elements S(16) to V(23) were studied.
2. A double crystal (calcite) spectrometer was used and intensities were recorded, using ion chamber detection.
3. Tables and spectra and a plot of satellite intensity as a percentage of the parent line intensity are presented.
4. The  $K\alpha''$  is the result of a KM ionization.

(4)E

Parratt, L. G.  $K\alpha$  SATELLITE LINES.  
Phys. Rev. 50, 1-15 (1936).

1. The  $K\alpha_{3,4}$  group of satellite lines for elements S(16) to Ge(32) were studied.
2. A double crystal (calcite) spectrometer with either  $CH_3Br$  or argon in the ionization chamber was used to obtain intensity data.
- 3a. Five component satellites for elements with  $16 \leq Z \leq 28$  and four component satellites for elements with  $29 \leq Z \leq 32$  were found.
- 3b. All spectra and tables of the wavelength, relative intensity, and the half-maximum line width for each satellite component are presented.

(5)E

Parratt, L. G. ON X-RAY SATELLITES, RELATIVE INTENSITIES, AND LINE WIDTHS.  
Phys. Rev. 50, 598-602 (1936).

1. The  $L\alpha_{1,2,3,4,5,6,7}$  lines of Ag and the  $M\alpha\beta$  lines of Au were studied.
2. A double crystal (calcite) spectrometer was used; intensities were recorded, using ion chamber detection.
- 3a. Spectra are presented.
- 3b. Discrepancies in interpretation of widths are due to differences in (a) the effective resolving power of the instrument used and in (b) the assumed shapes of the component lines comprising an unresolved complex structure.

(6)T

Richtmyer, R. D. THE PROBABILITY OF KL IONIZATION AND X-RAY SATELLITES.  
Phys. Rev. 49, 1-8 (1936).

1. A theory of the multiple ionizations produced by a fast cathode electron in the target of an X-ray tube is suggested, using potassium as an example.
2. The Born approximation of collision theory was used.
3. The results lead to the following transitions:

$$\text{Parent line } (1S)^2 s_{1/2} \rightarrow 2P \ ^2p_{3/2,1/2}$$

$$\text{Satellites } (1S2S)1^1 s_0 \rightarrow (2P2S)1^1 p_1 \ ^3p_{012}$$

(7)E

Shaw, C. H., and L. G. Parratt, THE  $K\alpha$  SATELLITES FOR Zn(30) TO Pd(46).  
Phys. Rev. 50, 1006-1011 (1936).

1. K spectra for  $Z = 30-46$  are presented.
2. A double crystal spectrometer was used.



(7)E Cont'd.

- 3a. Four component lines for  $30 \leq Z \leq 33$ , three component lines for  $34 \leq Z \leq 40$ , and two component  $\alpha_1^3$  and  $\alpha_4$  lines for  $41 \leq Z \leq 46$  were found.
- 3b. A sharp and anomalous decrease in total satellite intensity relative to  $\alpha_1$  intensity was found in the region of Y(39).
- 3c. Data are tabulated and spectra are presented.

(8)E

Yoshida, S. ALUMINUM K $\beta$  BANDS FROM Al-Cu ALLOYS. Sci. Papers Inst. Phys. Chem. Research (Tokyo) 28, 243-250 (1936).

1. Some 7 alloys ranging from 10-100% Al were studied.
2. A crystal spectrometer was used and intensities were recorded photographically.
- 3a. The Al bandwidth for K $\beta$  was 62.8 XU.
- 3b. As the Al percentage was decreased, the band was resolved into two overlapping peaks; the long wavelength peak (at 7970.9 XU) becomes stronger.
4. Brillouin zone overlap is responsible for the results.

1937

(1)E

Skinner, H. W. B., and J. E. Johnston, FINE STRUCTURE OF SOFT X-RAY ABSORPTION EDGE I: Li, Mg, Ni, Cu METALS. Proc. Roy. Soc. (London) A-161, 420-440(1937).

1. The Li-K; the Mg-L $_3$ , L $_2$ , L $_1$ ; Cu-M $_2$ ,  $_3$  and Ni-M $_2$ ,  $_3$  absorption edges were studied; specimens were 1-5 micron foils evaporated in vacuo onto celluloid-backed naphthalene.
2. A grating spectrograph at grazing incidence was used with intensities being recorded photographically; the continuous radiation source was a vacuum spark generated between metal electrodes 1.5 cm. from the slit.
- 3a. The fine structure and the edge spectra are presented in detail for all materials studied.
- 3b. No attempt to interpret the spectra is made but the results are tabulated.

1938

(1)E

Skinner, H. W. B., and J. E. Johnston, SOFT X-RAY BANDS FROM DILUTE ALLOYS. Proc. Cambridge Phil. Soc. 34, 109-114 (1938).

1. Alloys of Al-Cu, Be-Cu, and Be-Al were studied.
2. A one-meter grating spectrograph at grazing incidence was used; intensities were recorded photographically.
3. An attempt to correlate the results with the Mott-Jones theory of alloys was made; spectra are presented.
- 4a. All the valence electrons of the impurity atom are shared with the lattice.

- 4b. The impurity "selects" from the electrons in the lattice those which it chooses to have within it.

1939

(1)E

Beeman, W. W., and H. Friedman, THE X-RAY K ABSORPTION EDGES OF THE ELEMENTS Fe(26) to Ge(32). Phys. Rev. 56, 392-405 (1939).

1. Absorbers were prepared as follows: A 5-10 $\mu$  thick film of Fe, Co, Ni, and Cu was plated onto stainless steel and stripped off; Ga was used as a liquid and Ge as a powder.
2. A double crystal (calcite) spectrometer with a resolving power of 30,000 was used; intensities were measured with a Geiger counter.
- 3a. Spectra and tables of results are presented.
- 3b. Widths of K states ( $\pm 1/2$  volt) were assigned by matching theoretical arctangent curves to the experimental edges.
- 3c. The first empty levels above the Fermi surface were assigned wave length positions.
4. The K $\beta_5$  line is a dipole transition arising from the mixture of p function in the 3d bands.

(2)E

Burbank, C. J., NEW X-RAY LINES IN THE L SERIES RESULTING FROM K AUGER TRANSITIONS. Phys. Rev. 56, 142-146 (1939).

1. The L series of silver was studied.
2. A crystal spectrometer was used and intensities were recorded photographically.
3. Three new lines at 4.03A, 4.016A, and 3.805A were found.
4. These lines are due to processes in which an atom, initially ionized in the K shell undergoes transitions of the type:  
K  $\rightarrow$  LL + expelled electron (Auger transition)  
LL  $\rightarrow$  LM + photon (radiative transition).

(3)E

Johnston, J. E., THE FINE STRUCTURE OF THE X-RAY ABSORPTION EDGES OF Al AND Zn. Proc. Cambridge Phil. Soc. 35, 108-113 (1939).

1. The L $_{2,3}$  edges of Al and Zn were studied.
2. A concave 1 meter grating at grazing incidence in a vacuum spectrograph was used; a condenser spark between Cu electrodes was the light source, and intensities were recorded photographically.
- 3a. The spectra obtained and tabular results are presented.
- 3b. The spectra are described; no attempt to interpret them is made.

(4)E

Kliever, W. H., INTENSITIES OF K SERIES X-RAY LINES OF W AND Pt. Phys. Rev. 56, 387-391 (1939).

1. Intensities were found by determining, with a planimeter, the area under the curves of the X-ray lines vs. Bragg angle.

(4)E Cont'd.

2. A double crystal spectrometer (calcite in the 1,+1 position) equipped with an ionization chamber and amplifier was used.
3. Spectra and tabular results are presented.

(5)E

McGrath, J. W., THE DIFFERENCES BETWEEN THE  $M_5$  AND  $M_4$  ABSORPTION EDGES OF GOLD IN THE PURE METAL AND IN A GOLD-COPPER ALLOY.  
Phys. Rev. 56, 137-142 (1939).

1. The  $M_4$  and  $M_5$  absorption edges of pure Au and of Au in a 50 at/o Au-Cu alloy were studied; absorbers were evaporated onto a soft glass backing with a predetermined optimum absorber thickness being used.
2. A crystal spectrometer was used; intensities were recorded photographically.
3. The edge shifts were 6.8 and 2.5 eV for the gold  $M_4$  and  $M_5$ , respectively, in the alloy showing that the final levels of these transitions are lattice levels.
4. The results show that there are preferred atomic to low lattice level transitions which are often given by  $\Delta l = \pm 1$ .

(6)T

Richtmyer, R. D., THEORY OF X-RAY LINES LL-LM.  
Phys. Rev. 56, 146-152 (1939).

1. Quantum theory is applied to determine the transition probabilities from doubly ionized states of LL-LM type for Ag.
- 3a. It was assumed that the excitations of the initial (LL) levels arise from the internal conversion of K excitation energy.
- 3b. Complete tables of results are presented.

1940

(1)E

Bearden, J. A. and W. W. Beeman, K ABSORPTION EDGES AND  $K\beta_{2,5}$  EMISSION LINES OF TWO Zn-Ni ALLOYS.  
Phys. Rev. 58, 396-399 (1940).

1. The shapes of the  $K\beta_{2,5}$  emission lines and the K absorption edge of Zn and Ni in two Zn-Ni alloys containing 17 and 30 w/o Zn respectively were obtained.
2. A double crystal (calcite) spectrometer was used; intensities were recorded with the aid of a Geiger counter.
- 3a. The transitions responsible for the features were valence ( $K\beta_5$ ) or 3d electrons dropping into a K shell vacancy.
- 3b. Spectra and tabular results are presented.
- 3c. The Zn emission line was shifted one electron-volt toward lower energies and was narrowed, while the Ni line was changed only slightly.
4. Higher energy valence electrons of Zn are shared with nickel and probably go into the 3d states of the nickel atoms.

(2)E

Bearden, J. A. and H. Friedman, X-RAY  $K\beta_{2,5}$  EMISSION LINES AND K ABSORPTION LIMITS OF

Cu-Zn ALLOYS.

Phys. Rev. 58, 387-395 (1940).

2. A double crystal (calcite) spectrometer was used; intensities were recorded with the aid of a Geiger counter.
- 3a. Mixing Cu with Zn caused an increase in the high energy part of the  $Cu-K\beta_{2,5}$  emission and caused a decrease in the corresponding Zn- $K\beta_5$  emission.
- 3b. In every alloy the Zn- $K\beta_5$  appeared with very little change in width or intensity per Zn atom; hence, the Zn- $K\beta_5$  was assigned as a 3d quadrupole emission line.
- 3c. No shifts of the high energy sides of the lines or of the absorption edges were observed.
- 3d. There was no evidence of any effect of crystal structure on the emission lines.
- 3e. Spectra are presented for an entire series of Cu-Zn alloys.

(3)E

Friedman, H. and W. W. Beeman, COPPER AND NICKEL X-RAY  $K\beta_2$  and  $K\beta_5$  EMISSION LINES AND K ABSORPTION LIMITS IN Cu-Ni ALLOYS.  
Phys. Rev. 58, 400-406 (1940).

1. Pure Ni and Cu and Ni-30 w/o Cu, Ni-54 w/o Cu, and Ni-79 w/o Cu alloys were studied.
2. A double crystal (calcite) spectrometer was used; intensities were measured with a Geiger counter.
- 3a. Spectra are given in detail and tabular results are presented.
- 3b. The shapes of the Cu  $K\beta_{2,5}$  lines and the Ni  $K\beta_5$  lines vary smoothly with composition.
- 3c. The absorption edge data showed no influence of alloying.
4. The major effect of alloying in Cu-Ni is a loss of 3d band dipole radiation with dilution of the emitting atom.

(4)E

O'Bryan, H. M. and H. W. B. Skinner, THE SOFT X-RAY SPECTROSCOPY OF SOLIDS. II. EMISSION SPECTRA FROM SIMPLE CHEMICAL COMPOUNDS.  
Proc. Roy. Soc. (London) A176, 229-262(1940).

1. The K and L emission bands of fluorides, chlorides, bromides, iodides, oxides, sulfides, carbides, BN, and other boron compounds were investigated.
2. Two separate grazing incidence glass grating (30,000 lines per inch) spectrographs were used. The first was used for wavelengths below 50A and had a grazing angle of  $1.5^\circ$ . The second was used for all other wavelengths and had a grazing angle of  $6^\circ$ . Spectra were recorded photographically.
3. The observed spectra are presented and the p and s bandwidths are tabulated in eV. Comparison with the Sommerfeld bandwidth is fair.
4. The ratio of bandwidth to linewidth seems to be a measure of the degree of polarity in the compound.

(5)E

Randall, C. A.,  $L\alpha_1$  SATELLITE LINES FOR Mo(42) to Ba(56).  
Phys. Rev. 57, 786-791 (1940).

1. Satellite components for  $Z = 42-56$  are resolved.
2. Crystal spectrometry was used; the vacuum was  $10^{-4}$  mm Hg in the spectrometer.
- 3a. The Coster-Kronig crossover was found to occur at  $Z = 50$ .
- 3b. Some 30, instead of 15, gold satellites were found.
- 3c. Spectra and tabular data are presented.

(6)E

Skinner, H. W. B., THE SOFT X-RAY SPECTROSCOPY OF SOLIDS. I: K AND L EMISSION SPECTRA FROM ELEMENTS OF THE FIRST TWO GROUPS.  
Phil. Trans. Roy. Soc. (London) A239, 95-134 (1940).

1. Li, Be, Na, Mg, Al, Si, P, S, C, and B were studied.
2. A 1-meter grating spectrograph with a 15 mm grating surface, a slit width of 0.02 mm and a  $6^\circ$  grazing angle was used; spectra were recorded by photographic photometry.
3. Complete tables, spectra, and explanation of the results are given.
4. In determining the precise features of a band, the crystal structure of the material is the most important factor.

1941

(1)T

Sato, M., ENERGY STATES OF THE VALENCE ELECTRONS IN SOME METALS.  
Sci. Repts. Tohoku Univ. First Ser. 30, 267-286 (1941).

1. Level values for Zn are tabulated.
3. Tabular data on lower limit lines of the K absorption edge are given. These lines in Cu-Zn alloys are discussed.
4. Possible transitions to explain the results are suggested and attempts to justify them are made.

(2)E

Tomboulion, D. H. and W. M. Cady, THE L EMISSION BANDS OF Na, Mg, and Al.  
Phys. Rev. 59, 481-485 (1941).

1. Thin-evaporated films of Na, Mg, and Al were studied.
2. A 30,000 lines per inch glass grating at a grazing angle of  $5.1^\circ$  and a vacuum of  $4 \times 10^{-6}$  mm Hg was used. Spectra were recorded photographically.
- 3a. Spectra and tables of intensity distribution are presented.
- 3b. Bandwidths were:

Element

Bandwidth (eV)

Na	$3.05 \pm 0.10$
Mg	6.4
Al	10.6

(3)T

Tomboulion, D. H. and W. M. Cady, RADIATIVE X-RAY TRANSITIONS WITHIN THE L-SHELL.  
Phys. Rev. 59, 422-423 (1941).

1. The L-L radiation in the spectra of the lightest elements that have complete L shells was predicted.
2. The screening doublet law was used to make this prediction.
3. Tables of  $L_I - L_{II}$  probabilities for Na, Mg, and Al, and L terms and L-L lines of elements with  $Z = 11-26$  are presented.

1942

(1)T

Hayashi, T., NEW SYSTEMATIZATION OF X-RAY LINE SPECTRA SATELLITES OF Mg  $K\alpha$  and  $K\beta$  LINES.  
Sci. Repts. Tohoku Univ. First Ser. 31, 1-7 (1942).

- 1,2. Additional energy levels (quasi-stationary states) to account for satellite lines are postulated.
4. All Mg-K lines can be derived with this scheme.

(2)E

Hirsh, Jr., F. R., THE ABSENCE OF THE  $M\beta$  X-RAY SATELLITE INTENSITY ANOMALY.  
Phys. Rev. 62, 137-140 (1942).

1.  $M\beta$  satellites for the elements Ir to U (3.7-6A) were studied.
2. A crystal (quartz or calcite) spectrometer was used; intensities were recorded photographically.
- 3a. No  $M\beta$  satellite intensity maximum was found; this absence was explained in terms of the relative probability of Auger transitions, these relative probabilities being determined by means of diagram line widths.
- 3b. Tables and spectra are presented.

1945

(C-1)T

Beutler, H. G., THE THEORY OF THE CONCAVE GRATING  
J. Opt. Soc. Am. 35, 311-350 (1945).

- 1,2. A general theory of the image formation of the concave grating, based on Fermat's principle, is developed.
- 3a. Conditions for a focus, and various image defects such as astigmatism and coma are developed mathematically for several common types of mounting of the concave grating.
- 3b. Results of the computations are presented in the form of tables and charts.



## (C-1)T

Pauling, L., THE NATURE OF THE BONDS IN METALS AND INTERMETALLIC COMPOUNDS.

Proc. Intern. Congr. Pure and Appl. Chem.  
11, 249-257 (1947).

1. A general discussion of possible hybrids in metals and intermetallic compounds (AuSn, AuAl<sub>2</sub>, Cu<sub>3</sub>Sn) is presented.
- 3a. An equation for bond atomic radii was derived:  

$$R(l) - R(n) = 0.300 \log n$$
 where  $R(l)$  is the effective atomic radius for a single covalent bond and  $R(n)$  is the effective atomic radius for bond number  $(n)$ .
- 3b. The metallic radii for metal elements are given.

## (1)E

Coster, D. and S. Kiestra, ON THE EMPTY ELECTRON BANDS OF LOWEST ENERGY OF THE TRANSITION METALS Mn AND Fe AND THEIR OXIDES.  
Physica 14, 175-188 (1948).

- 1,2. A bent crystal spectrograph was used to study the K absorption spectra of Fe, Mn, and their oxides; intensities were recorded photographically.
- 3a. The initial absorption jump on the long wavelength side of the edge was attributed to a K electron transition to an empty state of the 4s band having p character.
- 3b. The oxides studied exhibited this initial jump effect to a much lesser extent than the pure metals.
- 3c. All spectra and density of states curves for Mn, Fe, Ni, and Zn are presented.

## (2)E

Tomboulou, D. H., RADIATIVE X-RAY TRANSITIONS WITHIN THE L-SHELL OF SULFUR.  
Phys. Rev. 74, 1887 (1948).

1. The  $L_1 \rightarrow L_{2,3}$  sulfur transition was found.
3. The line was 1.5 eV wide with a peak at 203A.
4. The absence of the  $L_1$  emission band is in part due to a radiative process within the L shell of the light elements.

## (C-1)T

Rundle, R. E., A NEW INTERPRETATION OF INTERSTITIAL COMPOUNDS - METALLIC CARBIDES, NITRIDES, AND OXIDES OF COMPOSITION MX.  
Acta Cryst. 1, 180-187 (1948).

1. Interstitial phases were regarded as electron-deficient structures, i.e., the non-metal forms more bonds than it has bond orbitals.
- 3a. The use of sp and p orbitals for M-X bonding was suggested.
- 3b. Resonance of sp and p bonds led to octahedral bonding.

3c,4. A single p orbital forms two bonds at 180° using a single electron pair (half-bond); the conditions for forming such a half-bond are outlined.

3d. Some physical properties are correlated with the proposed bonding scheme.

## (1)E

Cauchois, Y. and N. F. Mott, X-RAY ABSORPTION SPECTRA OF SOLIDS.  
Phil. Mag. (7) 40, 1260-1269 (1949).

1. Ni in NiS, Ni<sub>2</sub>O<sub>3</sub> and NiAs, Rb in RbCl, and metallic As, Ni and Ga, As in NiAs, Cu in CuO, and Cu<sub>2</sub>O and Zn in ZnO were studied.
2. A bent crystal (mica) spectrograph was used, and a record of the intensities was made photographically.
3. Actual experimental spectra and a tabulation of all data are presented.
4. The white ray at a K absorption edge may be due to a high density of normally unoccupied states with p symmetry in the neighborhood of the absorbing atom and/or the formation of excitation levels.

## (2)T

Hayashi, T., THEORY OF THE FINE STRUCTURE OF ROENTGEN K ABSORPTION SPECTRA: II. INFLUENCE OF THERMAL VIBRATION OF THE CRYSTAL LATTICE ON THE FINE STRUCTURE.  
Sci. Repts. Tohoku Univ. First Ser. 33, 183-194 (1949).

1. Broadening of K absorption bands, particularly those for Ni and Cu, were investigated.
2. Einstein's theory of specific heat was used and the width of the K absorption bands for Ni and Cu was calculated.
3. Fair agreement with experimental results was obtained.
4. The effect will be more prominent at very low temperatures.

## (3)T

Kostarev, A. I., INTERPRETATION OF HYPERFINE STRUCTURE OF X-RAY ABSORPTION IN SOLIDS. (In Russian.)  
Zhur. Eksptl. Teoret. Fiz. 19, 413-420 (1949).

1. BCC-Fe and FCC-Cu were studied.
3. For Cu, the 1st, 3rd, 5th, and 7th shells with intensity ratios of 10:4:2:3 are the major contributors to the hyperfine structure, while for Fe the first four layers are the major contributors with intensity ratios of 10:5:4:6.
4. The hyperfine structure is due to the scattering of the liberated electron by the shells of atoms surrounding the absorbing atom.

## (4)E

Morlet, J., THE K SPECTRUM OF Se AND THE L SPECTRUM OF Hg VAPOR. (In French.)  
Bull. Classe Sci. Acad. Roy. Belg. 35, 1059-1072 (1949).

(4)E Cont'd.

2. Radiation was analyzed with a curved crystal (mica) spectrometer having a first order dispersive power of 20XU/mm and intensities were photographically recorded.
- 3a. Some 85 lines of Hg were measured; many faint satellite lines and some intensity anomalies among the principal lines were discovered.
- 3b. The  $\alpha$  and  $\beta$  lines and satellites for solid and gaseous Se are listed.

(5)E

Vainshtein, E. E., K ABSORPTION LIMIT STRUCTURE OF NICKEL IN SOLUTION. (In Russian.) Doklady Akad. Nauk S.S.S.R. 69, 771-772 (1949).

1. Ni in  $\text{NiCl}_2$  and  $\text{NiSO}_4$  in aqueous and alcoholic solution corresponding to a 5-7 $\mu$  thickness of Ni metal was studied.
2. The structure of the K edge of Ni was identical in these dissolved compounds.

(6)E

Victoreen, J. A., X-RAY MASS ABSORPTION COEFFICIENTS. J. Appl. Phys. 20, 1141-1147 (1949).

1. Complete tables of constants for calculating  $\mu/\rho$  for  $Z = 1-100$  and for wavelengths less than the K critical absorption wavelengths are presented.
2. An empirical method to obtain the data was used.
- 3a. Partial tables give constants for  $\mu/\rho$  calculations for wavelengths between the  $L_1$  and  $M_1$  critical wavelengths.
- 3b. Calculated  $\mu/\rho$  is given for the common elements.

1950

(1)E

Cauchois, Y., K EMISSION DISCONTINUITIES OF AL AND Mg IN DILUTE ALLOYS. (In French.) Compt. Rend. (French Academy) 231, 574-576 (1950).

1. Alloys of Mg in Al and Al in Cu and in Al-Mg-Si were studied.
2. A bent crystal spectrograph was used and intensities were recorded photographically.
- 3a. All alloys studied showed sharp  $K\beta$  emission edges except Al - 95% Mg - 1.85% Si.
- 3b. For Al-Mg-Si alloy, a broad band was found at a longer wavelength than the usual  $K\beta$  emission edge.

(2)E

Cauchois, Y. and I. Manescu, K ABSORPTION SPECTRA OF Ni, ITS Ni-OXIDES, AND Ni ALLOYED WITH Cu. J. Chim. Phys. 47, 892-897 (1950). (In French.)

1. Ni,  $\text{Ni(OH)}_2$ , NiO,  $\text{Ni}_3\text{O}_4$ ,  $\text{Ni}_2\text{O}_3$ , and laminated sheets of Ni and Cu with Ni varying from 0.5-10% were studied.
2. A bent crystal spectrometer was used and

intensities were recorded photographically.

- 3a. Kronig structures somewhat like that of pure Ni varied slightly with concentration in the 2, 5, and 10% alloys of Ni in Cu.
- 3b. Spectra are presented.

(3)E

Coster, D. and S. Kiestra, FINE STRUCTURE NEAR THE IRON K ABSORPTION EDGES IN THE VARIOUS OXIDES OF IRON. Phil. Mag. (7) 41, 144-151 (1950).

1. Spectra for Fe in Fe oxides are presented.
2. A bent crystal (calcite) spectrograph was used; spectra were recorded photographically.
- 3,4. The data led to these conclusions:
  - a) In a region about 70 eV from the edge, the absorption coefficient is a property of the atom in question.
  - b) In a region 70-175 eV from the edge, the fine structure is determined by the immediate surroundings of the atom.
  - c) Above 175 eV, the fine structure depends on the crystal lattice.

(4)E

Das Gupta, K., THE SOFT X-RAY VALENCE BAND SPECTRA AND THE HEAT OF FORMATION OF CHEMICAL COMPOUNDS AND ALLOYS. Phys. Rev. 80, 281-282 (1950).

1. Mg, Al, Si, and their oxides, Si in SiC and the Fe- $L_3$  in  $\text{AlFe}_3$  were investigated.
2. A bent crystal (gypsum or mica vacuum spectrograph) was used.
3. An equation and a tabulation of data correlating the heat of formation of chemical compounds and alloys with soft X-ray valence band shifts are given.

(5)E

Deodhar, G. B., and C. Mande, FORBIDDEN LINES IN THE L SPECTRUM OF PLATINUM.

- J. Sci. & Indust. Res. (India) 98, 263-265 (1950).
2. A plane crystal spectrometer was used and spectra were recorded photographically.
  - 3a. Data are tabulated.
  - 3b. Two new lines at 1386.6 and 1110.6 XU respectively, corresponding to transitions  $L_3M_3$  and  $L_2M_5$ , were found.
  4. No one (up to 1950) has found  $\Delta l$  or  $\Delta j = 3$  for Pt.

(6)E

Edamoto, I, FINE STRUCTURE OF K SERIES X-RAY EMISSION SPECTRA FOR  $Z = 25-30$  and 32. Sci. Repts. Tohoku Univ. Ser. A-2, 561-612 (1950).

1. Fine structure data are obtained for  $Z = 25-30$  and 32.
2. A bent crystal (quartz-bent by author) spectrograph was used, capable of being read to 3' of arc; the spectrograph uses reference lines; the glancing angle  $\theta\alpha$  for  $K\alpha_1$  of quartz is tabulated; targets were 1 mm plates soldered to Cu anticathode.
- 3a. Individual data are presented for each element.

(6)E Cont'd.

- 3b. Line widths, asymmetry values, peak intensities, and the overlapping factor are tabulated and compared with Parratt's results (1936).
- 3c. The lines are resolved into components and the results are tabulated.
4. Resolved lines were of the "classical dispersion" type.

(7)A

Gokhale, B. G., EFFECT OF SLIT WIDTH ON LINE WIDTHS IN X-RAY SPECTRA. (In French.) Compt. Rend. (French Academy) 230, 636-638 (1950).

- 1,2. The intensity of a line obtained by photographic photometry is assumed to be:

$$I\lambda = I_{\lambda_0} \exp. [-(\lambda - \lambda_0)^2 \log 2/w^2]$$

$\lambda_0$  = wavelength for a maximum intensity.  
 $w$  = half-width at half-maximum of the line.

3. Since the dispersion is  $D = \frac{dx}{d\lambda}$  and  
 $x = (\lambda - \lambda_0)D$ ;  $I_0 = wD$   
and  $2S$  is the slit width; then the recorded intensity  $I_x$  is:

$$I_x = \int_{x-S}^{x+S} I_0 \exp [-x^2 \log 2/(I_0)^2] dx$$

(8)E

Hayashi, T., FINE STRUCTURE OF K ABSORPTION SPECTRUM - WAVELENGTH OF ABSORPTION MAXIMA IN K ABSORPTION SPECTRA OF Ni AND Cu. Sci. Repts. Tohoku Univ., First Ser. 33, 123-132 (1950).

1. Experimental data show that the Cu and Ni fine structure does not give sharp peaks.
2. The free-single electron method is used to calculate quasi-stationary states.
4. More quasi-stationary states of free-electrons exist than are possible when interference with electron waves due to the presence of neighboring planes of atoms is considered.

(9)T

Hayashi, T., THE FINE STRUCTURE OF THE K ABSORPTION SPECTRUM OF METALLIC Li. Sci. Repts. Tohoku Univ., First Ser. 34, 185-188 (1950).

1. Theoretical considerations (Ref. 8-1950) were extended to BCC-Li.
3. The theoretical values were compared with experimental results.
4. The theory is applicable to BCC-Li as well as to FCC-Ni and Cu.

(10)T

Hayashi, T., CRITICAL POTENTIALS FOR SOFT X-RAYS IN Li. Sci. Repts. Tohoku Univ., First Ser. 34, 189-191 (1950).

3. The critical potentials agree, in electron-volts, with quasi-stationary state energies.

4. The Auger effect may be used to explain the agreement of critical X-ray potentials with those of secondary electron emission.

(11)E

Hirsh, Jr., F. R., THE SATELLITES OF THE X-RAY LINE M $\beta$ . Physica 16, 377-378 (1950).

- 1,3. Data and discussion are presented leading to the result that the M $\beta$  satellites are exact counterparts of M $\alpha_1$  satellites; the data are in the form of plots of the square root of energy separation of satellite and parent vs. atomic number.
4. An ionization study with a double crystal vacuum spectrometer is suggested.

Niehirs, H., - See Review (R-7).

Vainshtein, E. E., - See Review (R-19).

(12)E

Vainshtein, E. E., STRUCTURE OF THE K ABSORPTION LIMIT OF TRANSITION ELEMENTS. (In Russian.) Doklady Akad. Nauk S.S.S.R. 70, 21-23 (1950).

1. It was assumed that the structure of the main absorption limit of atoms in metals represents a superposition of 2 or more limits.
- 3a. These limits correspond to a K-electron transition into a continuous energy band or to a free optical level.
- 3b. There is one transition for each state of ionization.

(13)E

Vainshtein, E. E., FORM OF X-RAY K $\alpha_1\alpha_2$  LINES OF Ni ATOMS IN THE SIMPLEST CHEMICAL COMPOUNDS. (In Russian.) Zhur. Eksptl. Teoret. Fiz. 20, 442-445 (1950).

1. Line widths and the index of asymmetry for Ni, NiSO $_4$ , NiO, Ni $_2$ O $_3$ , NiS, and Ni $_3$ S $_4$  were studied.
2. A bent crystal spectrograph was used.
3. When these compounds are prepared stoichiometrically, the Ni-K $\alpha$  lines are symmetrical.
4. Any asymmetry is due to Ni in 2 valence states in the compound.

(14)E

Vainshtein, E. E., FORM OF X-RAY K $\alpha_1$ ,  $\alpha_2$  LINES OF Cu AND Ni IN Cu-Ni ALLOYS. (In Russian.) Zhur. Eksptl. Teoret. Fiz. 20, 446-450 (1950).

1. The asymmetry index and line widths for eleven alloys are listed.
2. A bent crystal spectrograph was used.
3. Asymmetry decreases sharply at Cu:Ni ratios of: 1:1, 3:1, and 1:3.



(1)T

Averbukh, E. D., CALCULATION OF THE OPTIMUM ABSORBER THICKNESS FOR X-RAY ABSORPTION SPECTRA. Nauch. Byull. Leningrad Gosudarst. Univ. in. (In Russian.) A. A. Zhdanova 1951 (28) 8-11 Annotation from Chem. Abs. 49 -52f

3. Optimum thickness was given by

$$d_{\text{opt.}} = \frac{(\ln \mu_2 - \ln \mu_1)}{\mu_2 - \mu_1}$$

where  $\mu_1$  and  $\mu_2$  are the generalized mass absorption coefficients on either side of the absorption edge:

$$\mu = \frac{\mu' A'}{M} + \frac{\mu'' A''}{M} + \dots$$

where  $\mu'$ ,  $\mu''$  etc. are the mass absorption coefficients of individual elements in the absorbing compound. A, A', etc. are weight fractions of these elements. M is the compound's molecular weight.

(2)E

Barrere, G., NEW LINES IN THE X-RAY SPECTRA OF W AND Hg. (In French.) Compt. Rend. (French Academy) 233, 376-377 (1951).

1. A new line,  $L\gamma'$ , for W at 1090.5 XU was found.
2. This line was emitted by a W target excited at 400 kV.
3. The  $K\alpha_1$ ,  $K\alpha_2$  lines of Hg emitted by Au at 140 kV were 174.7 and 179.8 XU respectively.
4. The frequency of the K level of Hg is 6122v/R.

(3)E

Borovskii, I. B., FINE STRUCTURE OF X-RAY ABSORPTION STRUCTURES. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 15, 225-230 (1951).

1. The  $L_3$ ,  $M_3$ , and  $M_5$  absorption in  $UO_3$  and  $L_3$  and  $M_5$  absorption in  $UO_2$  were studied.
3. Homopolar bonds were found in  $UO_3$  while ionic bonds were found in  $UO_2$ .

(4)E

Deodhar, G. B., and C. Mande, A NEW NON-QUADRU-POLAR RADIATION IN THE PLATINUM L SPECTRUM. J. Sci. & Indust. Research (India) 10B, 260 (1951).

1. Forbidden lines in Pt spectra were studied.
3. Observed satellites are tabulated.

(5)E

Frilley, M., B. G. Gokhale and M. Valadares, THE INFLUENCE OF NUCLEAR MAGNETIC MOMENT ON LINE WIDTHS IN X-RAY SPECTRA. (In French.) Compt. Rend. (French Academy) 233, 1183-1186

1. Data were taken from Gokhale's line width data for  $Z = 37-50$  (Ref. 9, 1951).
2. Breit's formula was used to calculate the influence of the magnetic moment.
3. The influence of the moment is less than that required by theory; almost no hyperfine separation of K levels was found.

(6)T

Fujimoto, H. and S. Chiba, X-RAY K ABSORPTION EDGE ENERGIES OF ELEMENTS Li, Be, B and C. Sci. Repts. Tohoku Univ. 35, First Ser. 154-164 (1951).

- 1a. The K absorption energies of free atoms of Li, Be, B, and C were calculated by Skinner's method and each transition was listed.
- 1b. The ionization energies of atoms with  $(1s2s)^3s$  and  $(1s2s)^2$  configurations were calculated. The results are tabulated.
- 3a. The results of "1a" were compared to observed K edges and good agreement was found.
- 3b. The X-ray K-term value was calculated and tabulated.

(7)E

Glaser, H., THE ABSOLUTE ABSORPTION COEFFICIENT OF GERMANIUM AND THE FINE STRUCTURE IN THE K EDGE OF SOME OF ITS COMPOUNDS. Phys. Rev. 82, 616-621 (1951).

1. Absolute values for the K absorption limit of Ge in  $GeH_4$ ,  $Ge_2H_6$ ,  $GeCl_4$  and  $GeBr_4$  were obtained.
2. A double crystal (calcite) spectrometer was used; intensities were measured with a chlorine quenched argon proportional counter.
3. All spectra and a tabulation of energy shifts, fine structure details and the mass absorption coefficients are presented.

(8)A

Gokhale, B. G., ON A CURVED CRYSTAL SPECTROGRAPH HAVING A HIGH RESOLVING POWER. (In French.) Compt. Rend. (French Academy) 232, 1086-1088 (1951).

1. The characteristics of a mica curved crystal as compared to calcite in a double crystal spectrometer were discussed.
2. The theoretical resolving power was computed from Ewald's equations.
3. A higher resolution than that of the double-crystal spectrometer was claimed.

(9)E

Gokhale, B. G., WIDTH OF  $K\alpha$  LINES FOR Rb-Sn. (In French.) Compt. Rend. (French Academy) 233, 937-939 (1951).

1.  $K\alpha$  widths in XU for Rb-Sn are presented.
2. A bent crystal spectrometer was used, and intensities were photographically recorded.
- 3a. A plot of log of width for  $K\alpha_1$  vs. log Z was linear.
- 3b. The  $K\alpha$  width expressed in eV increased as  $Z^3$ .
- 3c. A correction of the widths for spectrometer broadening ranged from 0-8%.

(9)E Cont'd.

3d.	Element	K $\alpha_1$ Width (XU)	Element	Width	Element	Width
	Rb	0.303	Mo	0.260	Cd	0.230
	Sr	0.298	Ru	0.238	In	0.220
	Y	0.282	Rh	0.233	Sn	0.216
	Zr	0.273	Pd	0.229		
	Nb	0.268	Ag	0.230		

(10)E

Groven, L. and J. Morlet, WEAK RAYS IN THE K SERIES X-RAY EMISSION SPECTRA OF ELEMENTS BETWEEN Zn AND Kr. (In French.) Bull. Classe Sci. Acad. Roy. Belg. 37, 630-639 (1951).

2. The specimen was in the form of a rarified vapor which was excited by a damped electron wave; this excitation produced the desired X-rays.
3. The spectra obtained are systematically analyzed and an attempt was made at interpretation.

(11)E

Kingston, R. H., SPECTROSCOPY OF THE SOLID STATE: POTASSIUM AND CALCIUM. Phys. Rev. 84, 944-949 (1951).

1. The K and Ca radiation produced by transitions of the conduction electrons into the ionized 3p state of the atom was studied.
2. A grating spectrometer was used to study the thin evaporated films of K and Ca at a vacuum of less than  $10^{-5}$  mm Hg.
- 3a. Bandwidth data for Li, Be, Na, Mg, Al, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, and Zn were tabulated.
- 3b. Data for K and Ca are not in good agreement with theory.
- 3c. Spectra are presented.

(12)E

Kingston, R. H., A SPECTROSCOPIC STUDY OF THE ELECTRONIC STRUCTURE OF METALLIC POTASSIUM AND CALCIUM. Research Lab. of Electronics M.I.T., Tech. Rept. 193, 30 pp. (1951).

- 1,2. A grazing incidence grating spectrograph was used to study the emission bands of K and Ca at a pressure of  $10^{-6}$  mm Hg; radiation was produced by bombarding the target with 300-500 volt electrons at 2-6 ma and photons were counted by a Be-Cu photomultiplier.
- 3a. The radiation studied was produced in the evaporated targets by transitions of the valence electrons into the ionized 3p state of the atom.

- 3b. Detailed descriptions and diagrams of the apparatus are presented; actual and idealized spectra are shown.

3c.

Element	Emission edge (A)	Energy (eV)	Bandwidth (eV)
K	$675 \pm 2$	$18.4 \pm 0.1$	$1.9 \pm 0.2$
Ca	$500 \pm 2$	$24.8 \pm 0.1$	$3.0 \pm 0.2$

(13)E

Neff, H., ENERGY DISTRIBUTION IN A CONTINUOUS X-RAY SPECTRUM OF 1-2 kV ENERGY. (In German.) Z. Physik, 131, 1-9 (1951).

1. Pt, Ag, and Ni between 6 and 20 A were studied.
2. A plane grating vacuum spectrometer was used and radiation was collected with a photon counter.
3. The energy distribution was given by:  
$$E_\nu d\nu = CZ (\nu_0 - \nu) d\nu$$
$$\nu_0 = \text{frequency limit, } \nu = \text{frequency,}$$
$$Z = \text{atomic number.}$$
4. Deviations in the Z proportionality were thought to be due to screening effects.

(14)E

Parratt, L. G. and E. L. Jossem, X-RAY SPECTROSCOPY OF THE SOLID STATE. Phys. Rev. 84, 362 (1951).

- 1a. Preliminary work on the KB region of K and Cl in solid KCl was outlined.
- 1b. Some basic principles of solid state spectroscopy are briefly discussed.
- 3a. The lowest atomic level is 2.75 eV below the bottom of the 3p mother band for K and about 3.8 eV for the Cl case.
- 3b. The K-3p band has an intensity maximum near the low energy side.

(15)A

Piore, E. R., R. H. Kingston, and G. G. Harvey, SOFT X-RAY SPECTROSCOPY OF SOLIDS. Rev. Sci. Instr. 22, 543 (1951).

1. A description of the M.I.T. spectrograph - see Ref. #12 (1951) for details.

(16)E

Salgueiro, L. and G. Ferreira, THE SHAPE AND INTENSITY OF THE  $L\beta_2$  LINE OF GOLD AND ITS SATELLITE. (In French.) Portugalie Physica 2, 117-126 (1951).

2. A curved crystal spectrometer was used and intensities were recorded photographically.
- 3a. The ratio  $L\beta_2/L\beta_{15}$  (intensity) is 45.5/3.0.
- 3b. The ratio  $L\beta_2/\text{satellite}$  (intensity) is 0.11.

(17)E

Stewardson, E. A. and P. A. Lee, THE  $M_{IV}$  AND  $M_V$  ABSORPTION EDGE OF ERBIUM ( $Z=68$ ).  
Proc. Phys. Soc. (London) 64A, 318-319 (1951).

1,3. The positions of the  $M_{IV,V}$  for Er were:

$M_{IV}$  8583 XU  
 $M_V$  8829 XU

2. Oxide specimens were used.

(18)E

Tombouliau, D. H. and E. M. Pell, ALUMINUM ABSORPTION IN THE SOFT X-RAY REGION.  
Phys. Rev. 83, 1196-1201 (1951).

1. Al absorption was studied in the spectral region 80-600 A.
- 2a. A grating spectrometer was used, and spectra were recorded photographically on Ilford plates.
- 2b. The radiation source was a condensed spark discharge in a glass capillary which produced an intense line spectrum on a weak background.
- 3a. If evaporation was carried out at an interrupted rate, the deposits are sandwiches of pure metal and oxide.
- 3b. Fine structure was found on the short wavelength side of the  $L_{2,3}$  edge.
- 3c. The mass absorption coefficient  $\mu/p$  varied from  $1 \times 10^4$  cm<sup>2</sup>/g to  $2.8 \times 10^4$  cm<sup>2</sup>/g from 80-600 A.
- 3d. Actual spectra are presented.

(19)T

Vainshtein, E. E., R. L. Barinskii and K. I. Narbutt, THE THEORY OF THE PRINCIPAL X-RAY ABSORPTION EDGE OF ATOMS IN MOLECULES. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 77, 1003-1006 (1951).

1. The first two absorption lines were assumed to be due to the transition of K electrons to 4p and 5p levels.
- 3a. If this assumption is true the quantum defect,  $\Delta$ , is then 1.77.
- 3b. The potassium 4p absorption line is 2.7 eV from the true absorption edge -- in good agreement with experimental data.

(20)E

Vainshtein, E. E., R. L. Barinskii and K. I. Narbutt, STRUCTURE OF THE X-RAY ABSORPTION EDGE IN MOLECULES. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 78, 39-42 (1951).

1. The K edge of S in H<sub>2</sub>S, CS<sub>2</sub>, and SO<sub>2</sub> and the K edge of Cl in HCl were measured.
2. A bent crystal spectrograph was used, and intensities were photographically recorded.
- 3a. The polarizability was 20-50% below optical values.
- 3b. 

Compounds	Edge (eV)
S in H <sub>2</sub> S	182.49
S in CS <sub>2</sub>	182.37
S in SO <sub>2</sub>	182.65
Cl in HCl	208.36

(C-1)T

Fletcher, G. G. and E. P. Wohlfarth, CALCULATION OF THE DENSITY OF STATES CURVE FOR 3d ELECTRONS IN NICKEL.  
Phil. Mag. (7) 42, 106-110 (1951).

- 1,2. Results of  $N(E)$  tight binding approximation for the FCC lattice using Ni as an example are presented.
- 3a. A value of 2.70 eV for the total width of the Ni-3d band was obtained.
- 3b. An  $N(E)$  vs. energy curve for Ni is given.

(C-2)T

Kichenassamy, S., ON THE WIDTHS OF THE  $K\alpha_1$  LINES. (In French.)  
Compt. Rend. (French Academy) 232, 1074-1076 (1951).

1. Data (chiefly that of Gokhale) for elements of atomic number 36-50 are evaluated.
3. These data, as a function of  $Z^3$  and  $Z^4$  are plotted; the line width is a function of  $Z^3$ .
4. The reason for this  $Z^3$  dependence can be explained by Auger transitions.

(C-3)T

Senent, S. and Y. Senent, CALCULATION OF THE ORBITAL DENSITIES AND THE ORIENTATION OF THE VALENCE BANDS IN THE HYBRIDIZED STATE. (In Spanish.)  
Anales de la Real Sociedad Espanola de Fisica Y Quimica 47a, 197-220 (1951).

- 1,3. Values of orbital intensities and the orientation of directed valences are tabulated for all pure hybridizations.

(C-4)T

Torkington, P., THE GENERAL VALENCE ORBITALS DERIVABLE BY  $sp^3$  HYBRIDIZATION.  
J. Chem. Phys. 19, 528-533 (1951).

1. Sets of four  $sp^3$  hybrid orbitals satisfying the symmetry requirements of point groups  $C_{2v}$  and  $C_{3v}$  were examined; studies of deviations from the ideal tetrahedral valence angle found in systems of symmetry lower than  $T_d$  were made.
3. Tables of allowed interorbital angles are presented.

1952

(1)T

Agarwal, B. K., NOMENCLATURE OF X-RAY DIAGRAM LINES.  
Science and Culture (India) 17, 479-480 (1952).

- 1,2. The author suggests a new standard nomenclature system based on Sommerfeld's energy level configuration.
3. A diagram of transitions using this system is shown.



(2)E

Barinskii, R. L., X-RAY ABSORPTION SPECTRA OF MOLYBDENUM IN COMPLEXES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 83, 381-384 (1952).

1. The L absorption of Mo in  $(\text{NH}_4)_2 \text{MoO}_4$ ,  $\text{K}_4 \text{Mo}(\text{CN})_8$ , and  $\text{MoS}_2$  was studied.
- 3a. The  $\text{L}_3$  absorption lines of Mo are due to transitions of 2p electrons to excited states near the 4d level.
- 3b. Where 4d levels are used for bonding, there are no intense  $\text{L}_3$  lines.
4. The structure of the  $\text{L}_3$  absorption edge of Mo depends on the valence of Mo and also on the type of compound.

(3)E

Bhattacharjee, S. B., THE LOW-ENERGY SATELLITE OF THE VALENCE BAND SPECTRA OF SOME INSULATORS. J. Sci. & Indust. Research (India) 11B, 199-200 (1952).

1. Work on insulators and their spectra is presented.
- 3a. A table of bandwidths for some insulators is given.
- 3b. A schematic representation of the origin of low energy satellites in insulators is also given.

(4)E

Cauchois, Y., REMARKS ON THE TECHNIQUE FOR OBSERVING THE K SPECTRUM OF ALUMINUM. (In French.) Acta. Cryst. 5, 348-350 (1952).

1. The special features needed in a bent crystal spectrograph in order to study Al are outlined.
- 3a. The mica or gypsum crystals used must be absolutely free from traces of Al.
- 3b. For the 2-20A region, Kodak 1357 plates were found to be best.
- 3c. Attenuation tables for various windows, i.e., C, Be, and Li are given; the attenuation from a  $25\mu\text{Be}$  window is 55%.

(5)E

Cauchois, Y., A STUDY OF THE K ABSORPTION SPECTRUM OF METALLIC ALUMINUM. (In French.) Acta. Cryst. 5, 351-356 (1952).

1. The K absorption spectrum for Al down to 190 eV from the edge was measured.
2. A curved crystal (mica or gypsum) spectrometer was used and intensities were photographically recorded.
- 3a. The main edge is narrow and similar to the emission edge.
- 3b. Spectra and a tabulation of all results are presented.
4. The absorption bands are interpreted according to the Kronig theory for electrons traveling in an Al crystal.

(6)E

Cauchois, Y., PRELIMINARY REMARKS ON THE L-SPECTRUM, CONDUCTIVITY BAND AND COLOR OF SILVER. (In French.)

Compt. Rend. (French Academy) 235, 613-615 (1952).

2. A bent crystal spectrometer was used and intensities were photographically recorded.
- 3a. The  $\text{L}\beta_2$  line of Ag at 3695.6 XU is accompanied in the high frequency direction by a weak emission, attributed to the conduction band, with a short wave limit equal to the  $\text{L}_3$  absorption edge.
- 3b. The distance from the edge of this band to the center of the  $\text{L}\beta_2$  was 4 eV.

(7)T

Cauchois, Y., ENERGY LEVELS OF HEAVY ATOMS. J. Phys. Radium 13, 113-121 (1952).

1. Results are based on X-ray data for elements of  $Z = 73-92$ .
2. The energy zero was the  $\text{L}_3$  discontinuity.
3. The mechanism of the photoelectric absorption of X-rays and the origin of discontinuous absorption is discussed.

(8)T

Curie, D., WIDTH OF SPECTRAL LINES AND HYPERFINE STRUCTURE IN THE X-RAY SPECTRA. (In French.) J. Phys. Radium 13, 505-515 (1952).

1. The fact that the absence of line broadening or hyperfine structure of K lines occurs due to a nuclear magnetic moment is discussed.
4. This result is explained by postulation that the usual theory of spectral line width is not valid when photons of the same frequency are emitted by two distinct levels whose separation is less than their width.

(9)E

Deodhar, G. B. and C. Mande, NEW FORBIDDEN LINES IN THE L SPECTRUM OF MERCURY. J. Sci. & Indust. Research (India) 11B, 1-4 (1952).

1. Forbidden lines in Hg spectra were studied.
2. The vacuum line to the anti-cathode was sealed with Apiezon Q sealing compound.
3. Results are tabulated and a method for setting up the Hg specimen on the anti-cathode is given.

(10)E

Deodhar, G. B. and C. Mande, NON-QUADRUPOLE LINES IN X-RAY SPECTRA. Nature 169, 889 (1952).

1. Some lines not obeying quadrupole selection rules in the L spectra of Pt and Hg were found.
3. Some of the energy of non-quadrupole lines is dissipated in the process of emission itself.
4. Only those non-quadrupole lines for which  $\Delta l$  or  $\Delta j$  both are simultaneously zero can be observed and if  $\Delta l$  or  $\Delta j$  is 3, one cannot observe a non-quadrupole line.

(11)E

Doughty, D. D. and J. W. McGrath, THE  $M_5$  and  $M_4$  X-RAY ABSORPTION EDGES OF Ta.  
Phys. Rev. 85, 1040 (1952).

1. The edge wavelengths and  $\nu/R$  for the  $M_4$  and  $M_5$  edges of Ta are tabulated.
2. A 13.94 cm radius Siegbahn spectrograph was used to study thin ( $4 \times 10^{-5}$  cm) evaporated films of Ta; photographic exposures were 50 hours long.
3. 

Edge	Wavelength (XU)	$\nu/R \pm 0.1$
$M_5$	$7033 \pm 5$	129.3
$M_4$	$6845 \pm 5$	132.8

(12)E

Faessler, A. and M. Goehring, X-RAY SPECTRA AND CHEMICAL BONDING. (In German.)  
Die Naturwissenschaften 8, 169-177 (1952).

1. The  $K\alpha$  for sulfur in many organic and inorganic compounds was investigated.
2. A crystal spectrometer was used and spectra were obtained by photographic photometry.
3. All spectra are presented.

(13)T

Friedel, J., X-RAY TRANSITION PROBABILITIES WITH SPECIAL REFERENCE TO K ABSORPTION IN LITHIUM.  
Phil. Mag. (7) 43, 1115-1139 (1952).

1. Formulae for total jump in absorption coefficients at K, L, and M X-ray absorption edges are given.
2. It was assumed that the positive hole created in an inner shell is screened by a bound electron and encloses the metal in a finite sphere in order to apply physico-mathematical computations.
3. Projected spectra based on the computational results are given.

(14)E

Gokhale, B. G., STUDY OF THE WIDTH OF LINES IN X-RAY SPECTRA. (In French.)  
Annales de Physique 7, 852-902 (1952).

1. The K spectra for elements of atomic number 37-50 were studied.
2. A bent crystal (mica) transmission spectrograph was used and intensities were obtained by photographic photometry.
- 3a. If the magnetic moment of an atomic nucleus produces hyperfine splitting of X-ray levels, the effect is small.
- 3b. The line width increases as  $Z^3$ .

(15)E

Gyorgy, E. M. and G. G. Harvey, THE SPECTROSCOPY OF THE SOLID STATE: COPPER AND CHROMIUM.  
Phys. Rev. 87, 861-862 (1952).

1. The  $3p_{3/2,1/2}$  (valence to  $M_{2,3}$ ) emission bands in Co and Cr were obtained.

2. A glass grating spectrograph at grazing incidence was used. The bombarding voltage was 500 v. for Cu and 600 v. for Cr, with a resultant target current of 3 ma. Intensities were measured with a Be-Cu photomultiplier.

3a. Both curves show high energy satellites.

3b. Spectra and density of states curves are given.

Element	Bandwidth (eV)	$M_{2,3}$ emission edge (eV)	$M_{2,3}$ separation (eV)
Cu	$7.1 \pm 0.5$	$75.9 \pm 0.2$	$1.2 \pm 0.1$
Cr	$7.2 \pm 1.0$	$742.1 \pm 0.2$	$0.45 \pm 0.1$

(16)A

Hill, R. D., E. L. Church and J. W. Mikelich, THE DETERMINATION OF  $\gamma$ -RAY ENERGIES FROM  $\beta$  RAY SPECTROSCOPY AND A TABLE OF CRITICAL X-RAY ABSORPTION ENERGIES.  
Rev. Sci. Instr. 23, 523-528 (1952).

1. A complete table of critical X-ray absorption energies is given with interpolations and extrapolations for  $Z = 3-100$ .

(17)E

Hirsh, Jr., F. R., AUGER ENHANCEMENT OF THE  $M\alpha$  X-RAY SATELLITE LINES.  
Phys. Rev. 85, 685-686 (1952).

1. Photometer traces of plates for  $M\alpha$  lines of Pt, Au, Tl, Pb, Bi, Th, and U are presented.
- 3a. The spectra shown have a complete absence of sharp satellite maxima caused by Auger broadening of the satellites.
- 3b. The relative energy of double to single ionization vs. atomic number is plotted.
4. The results favor the theory of Coster and Kronig.

(18)E

Kiyono, S., K-ABSORPTION SPECTRA OF POTASSIUM IN KF, KCl, KBr, and KI.  
Sci. Repts. Tohoku Univ. First Ser. 36, 1-17 (1952).

1. KCl, KBr, KI, and KF were studied.
2. A bent crystal (quartz - 50 cm radius) vacuum spectrograph with a Sandstrom (dry air discharge) tube equipped with a W anticathode was used to make 10-40 hour photographic exposures with a dispersion of 5.5 eV/mm.
3. Photometer traces are presented.
4. Values of  $\lambda$ ,  $\Delta\lambda$ ,  $\nu/R$ ,  $\Delta\nu/R$  and  $\Delta\nu$  are tabulated from this and earlier work.

(19)E

Mitchell, G. and W. W. Beeman, THE X-RAY K ABSORPTION EDGES OF COVALENTLY BONDED Cr, Mn, Ni and Fe.  
J. Chem. Phys. 20, 1298-1301 (1952).

1. Spectra and bonding data are presented.
2. Crystal spectrography was employed.
- 3a. The metal ion is nearly neutral in a complex.



(19)E Cont'd.

- 3b. Low energy absorption is observed in all complexes where an empty 4p orbital is expected, but when the 4p orbital is completely used in bonding no low energy absorption is observed.
4. The results may be used as a check on bonding orbitals.

(20)E

Nilsson, N., K ABSORPTION LIMIT IN ANTIMONY.  
Arkiv Fysik 3, 167-169 (1952).

1. Absorption data for Sb are tabulated.
2. A bent crystal (quartz) spectrograph was used and intensities were recorded photographically.
3. The K edge is at 4.7 Å for Sb.

(21)A

Ohlin, P., SPECTROMETER TO INVESTIGATE THE ANGULAR DEPENDENCE OF STRUCTURE IN THE CONTINUOUS X-RAY SPECTRUM.  
Arkiv Fysik 4, 387-390 (1952).

1. A new quartz crystal spectrograph is described in detail.
3. Preliminary data on Cu are presented.

(22)A

Piore, E. R., G. G. Harvey, E. M. Gyorgy and R. H. Kingston, A HIGH VACUUM RECORDING SPECTROGRAPH FOR THE STUDY OF RADIATION FROM SOLIDS IN THE 100-800 Å range.  
Rev. Sci. Instr. 23, 8-12 (1952).

1. A description of the M.I.T. spectrometer is given. See Ref. No. 8 (1953) for details.

(23)A

Sandstrom, A. E., A LARGE BENT CRYSTAL VACUUM SPECTROGRAPH.  
Arkiv Fysik 4, 517-534 (1952).

- 1a. A complete description of all phases of design and building of a bent crystal spectrograph is given.
- 1b. Photographs and diagrams of the apparatus are presented.

(24)E

Shinoda, G., T. Suzuki and S. Kato, ELECTRONIC SPECTROSCOPY FOR THE SOFT X-RAY REGION.  
J. Phys. Soc. Japan 7, 644-645 (1952).

1. The method of photoelectronic spectroscopy coupled with electronic differentiation is discussed.
2. The circuit diagram for the apparatus is given.
- 3a. Resolution was calculated to be  
$$= 3.52 (kT/ch)\lambda^2$$
where  $k$  = Boltzmann constant,  $T$  = absolute temperature,  $c$  = speed of light,  $h$  = Planck constant,  $\lambda$  = wavelength.
- 3b. The emission band for Al-L<sub>3</sub> is shown.

(25)T

Vainshtein, E. E., THE X-RAY ABSORPTION EDGE OF TRANSITION ELEMENTS IN COMPOUNDS. (In Russian.)

Doklady Akad. Nauk S.S.S.R. 82, 355-358 (1952).

1. Lines on the long wavelength side of the edge are discussed; these lines are connected with the existence of vacancies in nd and nf electron shells.
3. The positions of these lines vary less from compound to compound for a given element than do other features of the absorption edge.
4. This is attributed to transitions of the absorber to energy levels of the solid which are close to nd and to nf levels of the free atom of the transition metal.

(26)E

Zandy, H. F., THE M<sub>IV</sub> AND M<sub>V</sub> ABSORPTION EDGES OF Pr, Nd, Sm, and Eu.  
Proc. Phys. Soc. (London) 65A, 1015-1022 (1952).

1. Tables of spectra for Pr, Nd, Sm, and Eu are presented.
2. A curved crystal (mica) spectrometer evacuated to 10<sup>-5</sup> mm Hg was used to study thin evaporated films of the specimens and to record spectra photographically; the instrument had a dispersion of 40 XU/mm at 10,000 XU.
3. Fine structure was found on both edges for Pr, Nd and Sm but for Eu fine structure was observed only at the M<sub>V</sub> edge.

(C-1)T

Antonicik, E. and M. Trlifaj, GROUP ANALYSIS OF THE WAVE FUNCTIONS OF VALENCE ELECTRONS IN A CRYSTAL AND THE ELECTRONIC THEORY OF METALLIC Mg. (In English).  
Czech. J. Phys. 1, 97-120 (1952).

- 1,2. Group analysis of the wave functions of valence electrons in the first Brillouin zone was performed.
- 3a. The binding energy of Mg was calculated.
- 3b. Explanation of the Mg soft X-ray emission spectrum is based on the calculated data.

(C-2)T

Aoki, Y., NUMERICAL TABLES OF OVERLAP INTEGRALS FOR 3s, 3p HYBRID ATOMIC ORBITALS.  
J. Phys. Soc. Japan 7, 451-457 (1952).

- 1,2,3. Numerical calculations for 3s, 3p, and 1s, 2s, 3s, 3p hybrid orbitals are tabulated; Slater's atomic orbitals were employed for the calculations.

(C-3)T

Baldock, G. R., ELECTRONIC BOUND STATES AT THE SURFACE OF A METAL.  
Proc. Cambridge Phil. Soc. 48, 457-469 (1952).

1. Bound states for all atoms in a metal surface and for particular small groups of atoms in a simple cubic lattice were determined.
2. The tight binding method was used to find the bound states associated with atoms in the surface of a metal.
3. Most simpler crystals do not exhibit surface states without modifications in the parameters of certain atoms.

(C-4)T

Coulson, C. A. and R. Taylor, STUDIES IN GRAPHITE AND RELATED COMPOUNDS: I. ELECTRONIC BAND STRUCTURE IN GRAPHITE.  
Proc. Phys. Soc. (London) 65A, 815-825 (1952).

- 1,2. The Bloch (tight binding) theory is used to calculate the density of states in graphite.
- 3a. Density of states curves with and without use of overlap integrals are presented.
- 3b. The density of states curve calculated is compared favorably with Chalkin's experimental X-ray emission curve.
4. The  $\sigma$  electrons play an important role in determining the band shape.

(C-5)T

Fletcher, G. C., DENSITY OF STATES CURVE FOR THE 3d ELECTRONS IN NICKEL.  
Proc. Phys. Soc. (London) 65A, 192-202 (1952).

1. A density of 3d states in metallic Ni was calculated.
2. The method of tight binding (Bloch) was used.
- 3a. The secular equation for the energy as a function of wave vector was solved exactly.
- 3b. Bandwidth is 2.7 eV; degeneracy temperature is  $1.45 \times 10^3$  °K.
- 3c. A density of states curve is presented.

(C-6)T

Friedel, J., THE DISTRIBUTION OF ELECTRONS ROUND IMPURITIES IN MONOVALENT METALS.  
Phil. Mag. (7) 43, 153-189 (1952).

1. The distribution of a positively charged impurity such as dissolved hydrogen or atoms like Zn or Ga was investigated.
- 3a. The positive charge must be screened; this may often occur through the formation of bound states below the Fermi level.
- 3b. An X-ray vacancy was treated as a positive impurity.
- 3c. Many diagrams illustrating these points are presented.

(C-7)T

Lee-Whiting, G. E., X-RAY ABSORPTION LINE-WIDTH AND ELECTRON STOPPING POWER CALCULATED WITH A SCREENED COULOMB INTERACTION.  
Proc. Roy. Soc. (London) A212, 362-376(1952).

1. It was assumed that the polarization of a free electron gas about an electron moving through it gives rise to an exponential screening of the Coulomb potential.
- 3a. With such an interaction, a method was found for calculating the frequency of collisions and the rate of energy loss of an excited electron.
- 3b. The X-ray absorption line width and the stopping power of the electron cloud were deduced to be high energy asymptotic expansions.

1953

(1)E

Alexopoulos, K. and G. Brogren, EVIDENCE OF A BAND STRUCTURE IN THE COMPTON RADIATION FROM SOLIDS.  
Arkiv Fysik 6, 213-222 (1953).

1. The Compton bands of Be and diamond were studied.
2. The X-ray scattering was monitored.
- 3a. Diamond has an energy gap of 7 eV.
- 3b. Spectra and tabular results are presented.

(2)E

Borovskii, I. B. and T. M. Golovner, MULTIPLICITY IN X-RAY EMISSION SPECTRA.  
Doklady Akad. Nauk S.S.S.R. 88, 233-236 (1953). Trans: NSF-tr-7, 3 pp. (1953).  
Available from Library of Congress.

1. Data on electron configurations and transitions in the rare earth elements (Ce to Lu) are presented.

(3)E

Cauchois, Y., THE L SPECTRA OF NICKEL AND COPPER.  
Phil. Mag. (7) 44, 173-186 (1953).

1. Both the absorption and emission bands of Ni and Cu were studied.
2. A bent crystal spectrograph (mica or gypsum) was employed, and spectra were recorded photographically.
- 3a. Complete tables of results are given as well as the experimental spectra.
- 3b. The band for Cu is in agreement with Mott's theory of the behavior of electrons in Cu.
4. Density of states curves are postulated on the basis of the data.

(4)E

Cauchois, Y., THE K EMISSION SPECTRUM OF ALUMINUM IN THE REGION OF THE CONDUCTION BAND.  
(In French.)  
Acta Cryst. 6, 352-356 (1953).

2. A bent crystal (mica) spectrometer was used and intensities were photographically recorded.
- 3a. Spectra are presented and their features are listed.
- 3b. The K emission bandwidth was found to be  $10 \pm 1$  eV with one feeble minimum and two maxima; the width of the discontinuity was 1.5 eV.
4. The band shape was explained in terms of the transition probabilities of conduction electrons to bound states of the atom. The mechanism is carefully diagramed.

(5)T

Deodhar, G. B. and B. K. Agarwal, NOMENCLATURE OF X-RAY LINES.  
J. Sci. & Indust. Research (India) 12B, 639-641 (1953).

1. A system of nomenclature was proposed.
3. Tables comparing the new satellite notation with old are given.

(5)T Cont'd.

4. New system is easier to work with and to understand.

(6)T

Eisenlohr, H. and G. L. Muller, X-RAY SCATTERING IN REGION OF K AND L EDGES OF HEAVY ATOMS. (In German.)  
Z. Naturforsch, 8a, 429-432 (1953).

1. The dispersion for a spectral region reaching from wavelengths through the K and L absorption edges was calculated.
2. Wave-mechanical dispersion theory was used.
- 3a. Atomic scattering factor curves are plotted for Te and W.
- 3b. These show systematic deviations from other curves.

(7)E

Gyorgy, E. M., M-EMISSION BANDS OF THE TRANSITION METALS IN THE SOLID STATE.  
Research Lab. of Electronics M.I.T. Tech. Rept. 254, 34 pp. (1953).

- 1,2. Cu, Ni, Fe, Mn, and Cr were studied with a grazing incidence grating spectrograph at a pressure of  $10^{-6}$  mm Hg; radiation was produced by bombarding the target with 300-500 volt electrons at 2-6 ma, and photons were counted by a Be-Cu photomultiplier.
- 3a. The radiation studied was produced in the evaporated targets by transitions of valence electrons into the excited  $3p_{3/2,1/2}$  states of the atom.
- 3b. All spectra and the density of states curves derived from them are presented.
- 3c. Bandwidth and emission edge data are tabulated.

(8)E

Hartman, P. L. and D. H. Tomboulion, FAR ULTRA-VIOLET RADIATION FROM THE CORNELL SYNCHOTRON.  
Phys. Rev. 91, 1577-1578 (1953).

1. This letter describes the use of the Synchrotron as a source of continuous radiation for the 50-400 Å spectral region.
2. The synchrotron energy was 220 and 310 MeV; both settings produced a strong continuum.
3. The photographic negatives over the 50-400 Å region showed no marked density variations, and no sudden drop over the short-wavelength region available under the particular conditions of detection.

(9)E

Herglotz, H., SECONDARY EXCITATION OF THE  $K\alpha_3$  SATELLITE OF Cr. (In German.)  
Oster. Akad. Wiss. Math. Naturiv. Kl. Sitzber. Abt. IIa 162, 235-252 (1953).

- 1,2a. The  $K\alpha_3$  satellite was excited from Cr which was the anticathode in a Cu X-ray tube and also from Cr exposed to Fe- $K\alpha$  radiation in air.
- 2b. The  $K\alpha_1$  and  $K\alpha_2$  lines were exposed such that they were of equal density on a calibrated photographic film.

3. The ratio of  $K\alpha_3$  primary to  $K\alpha_3$  secondary was 2.5 as determined by microphotometry.

(10)E

Morlet, J., CONSTRUCTION OF A SPECTROGRAPH FOR SOFT X-RAYS OF WAVELENGTH 2-20 Å; L EMISSION SPECTRA OF WAVELENGTH 9-14 Å. (In French.)  
Bull. Classe Sci. Acad. Roy. Belg. 39, 205-216 (1953).

1. The L series spectra for Zn, Cu, and Cu-Zn alloys are presented.
2. Details of the construction of the curved crystal spectrometer used are given; the spectrometer records intensities photographically.
3. The effects of alloying on the spectra were tested.

(11)E

Nilsson, A., A PRECISION DETERMINATION OF THE K EXCITATION POTENTIAL OF SOME 3d ELEMENTS.  
Arkiv Fysik 6, 513-592 (1953).

1. This is a thesis in toto.
2. A complete discussion of apparatus and techniques is given.
3. Tables and discussion, in full, of results and their implications are presented.

(12)E

Rogosa, G. L. and G. Schwarz, MOLYBDENUM K AND URANIUM L X-RAY TRANSITIONS FROM SEPARATED ISOTOPES.  
Phys. Rev. 92, 1434-1437 (1953).

1. The  $K\alpha$  ( $K \rightarrow L_3$ ,  $K \rightarrow L_2$ ) lines of Mo and the  $L\beta_1$  ( $L_2 \rightarrow M_4$ ) of U were measured in separated isotopes.
2. A double crystal spectrometer was used; experimental technique is briefly outlined.
3. Results are tabulated.

(13)E

Sakellariadis, P., ENERGY LEVELS AND WEAK EMISSIONS IN THE RARE EARTHS Tm, Ho, Tb, Gd, and Eu. (In French.)  
Compt. Rend. (French Academy) 236, 1767-1769 (1953).

1. The  $Lm$  was used as the absorption reference; data were taken from the work quoted in Refs. 14, 15, 16 (1953).
2. To obtain the value for each level, all frequency differences possible were calculated from the measured transitions.
3. Wavelengths and energies are tabulated for the five rare earths concerned.

(14)E

Sakellariadis, P., L EMISSION AND ABSORPTION SPECTRA OF Eu AND Tb.  
Compt. Rend. (French Academy) 236, 1547-1549 (1953) (In French).

1. Eu and Tb in  $Eu_2O_3$  and  $Tb_2O_3$  respectively were studied.
2. A bent crystal (mica) spectrograph was used and intensities were photographically recorded.



(14)E Cont'd.

3. Wavelengths for  $L_1$ ,  $L_2$ , and  $L_3$  absorption edges (max. and min.) and the dipole and quadrupole emission lines due to transitions between the L, M, N, and O levels are tabulated.

(15)E

Sakellariadis, P., L EMISSION AND ABSORPTION SPECTRA OF GADOLINIUM AND THULIUM. (In French.)  
Compt. Rend. (French Academy) 236, 1244-1246 (1953).

1. Gd and Tm in  $Gd_2O_3$  and  $Tm_2O_3$  respectively were studied.
2. A bent crystal (mica) spectrograph was used and intensities were photographically recorded.
3. Wavelengths for  $L_1$ ,  $L_2$ , and  $L_3$  absorption edges (max. and min.) and the dipole and quadrupole emission lines due to transitions between the L, M, N, and O levels are tabulated.

(16)E

Sakellariadis, P., L EMISSION AND ABSORPTION SPECTRA OF HOLMIUM. (In French.)  
Compt. Rend. (French Academy) 236, 1014-1016 (1953).

1. Ho in a very pure sample of  $Ho_2O_3$  was studied.
2. A bent crystal (mica) spectrograph was used and intensities were photographically recorded.
3. Wavelengths for  $L_1$ ,  $L_2$ , and  $L_3$  absorption edges (max. and min.) and the dipole and quadrupole emission lines due to transitions between the L, M, N, and O levels are tabulated.

(17)E

Schwarz, G. and G. L. Rogosa, ELECTRONIC EXCITATION OF THE  $L_{III}$  STATE OF 5d ELEMENTS.  
Phys. Rev. 92, 88-89 (1953).

1. The ratio  $h/e$  was measured from the electronic excitation potential of one of the X-ray levels and a structure in the K excitation curves for Ta, Pt, and W was found.
2. A double crystal spectrometer was used; trouble with target contamination occurred.
3. The  $L_3$  excitation curves for Ta, Pt, and W are given.
4. The observed structure can be related to the density of states in the conduction band.

(18)E

Townsend, J. R., SOLID STATE ABSORPTION SPECTRA OF Mg AND MgO.  
Phys. Rev. 92, 556-560 (1953).

1. The linear absorption coefficients for Mg and MgO in the spectral region 80-350 Å were determined.
- 2a. A glass grating spectrometer was used at a grazing angle of  $5^\circ$  to study the evaporated specimens (MgO was made by oxidizing the Mg foil); intensities were recorded photographically.

- 2b. The source of radiation was a condensed spark discharge.

- 3a. The absorption coefficient ranges from  $1.8 \times 10^4 \text{ cm}^{-1}$  (at 80Å) to  $12 \times 10^4 \text{ cm}^{-1}$  (at 350Å) in Mg.
- 3b. A gap of about 4 eV exists between the top filled level and the proposed conduction band in MgO.
- 3c. An electronic energy level scheme for MgO was proposed and a diagram of it presented.

(C-1)T

Friedel, J., ANOMALY OF  $M_{IV,V}$  ABSORPTION IN HEAVY ELEMENTS.  
Proc. Phys. Soc. (London) 66A, 333-340 (1953).

- 1,2. The Wigner-Seitz method was used to compute energies.
- 3a. An anomaly was observed for the 4f band in the second long period.
- 3b. The anomaly disappears from Ra through U; therefore, the conduction band of these elements must contain some 5f states.
4. The transition probability of a 3d electron to the top of the conduction band is small; strong absorption begins only when the ejected electron reaches the bottom of the 5f band.

(C-2)T

Hume-Rothery, W., METALLIC CARBIDES AND NITRIDES OF THE TYPE MX.  
Phil. Mag. (7) 44, 1154-1160 (1953).

1. Structures of MX types with the NaCl configuration were examined to see if this configuration was formed in order to provide the non-metal with an octahedral interstice.
4. The NaCl structure is formed to provide the metal with mutually perpendicular bonds to six neighbors.

(C-3)E

Johnson, F. A. and J. S. Foster, AUGER TRANSITIONS IN SILVER.  
Can. J. Phys. 31, 469-471 (1953).

1. Some 20 K-Auger lines of Ag were recorded.
2. A permanent-magnet spectrograph was used, and intensities were recorded on Kodak X-ray film.
3. The results disagree with theory, the greatest discrepancy occurring for  $K \rightarrow LL$  transition lines.
4. The authors feel that the theory is quantitatively incorrect.

(C-4)E

Lander, J. J., AUGER PEAKS IN THE ENERGY SPECTRA OF SECONDARY ELECTRONS FROM VARIOUS MATERIALS.  
Phys. Rev. 91, 1382-1387 (1953).

1. The energy spectra of secondary electrons from C, Be, Al, Ni, Cu, Ba, Pt, BeO,  $Al_2O_3$ , N, O, CuO, and BaO were measured.
2. A spherical electron velocity analyzer which could be evacuated to  $1 \times 10^{-8}$  mm Hg was used.
- 3a. Characteristic peaks due to Auger electrons were observed in all the materials examined.

(C-4)E Cont'd.

- 3b. Spectra and tabular results are presented.
4. Structure in the peaks can be related to the distribution in energy of electrons in the valence band, and it complements that observed in soft X-ray emission studies.

(C-5)T

Laskar, W., SEMIDIRECT DETERMINATION OF COEFFICIENTS OF FLUORESCENCE FOR THE K LEVEL OF CERTAIN ATOMS FROM MEASUREMENTS OF THE WIDTH OF X-RAYS. (In French.)  
Compt. Rend. (French Academy) 236, 2149-2150 (1953).

- 1,2. Gokhale values for the  $K\alpha_1$  shell width were used to calculate the fluorescence coefficient of the K shell for eight elements.

Element	Fluorescence Coefficient
Sr	0.65
Zr	0.69
Mo	0.73
Rh	0.78
Pd	0.80
Ag	0.81
Cd	0.828
Sn	0.83

(C-6)T

Meerson, G. A. and Ia. S. Umanskii, ON THE HARDNESS OF REFRACTORY CARBIDES. (In Russian.)  
Izvestia Sektora Fiziko-Khimicheskogo Analiza 22, 104-110 (1953).  
Trans. AEC-tr-3629, 6 pp. (1960).

1. The hardness of carbides in general terms of directional bonds is discussed.
3. Tables of carbide types and of the free energy of carbide formation are presented.

(C-7)T

Sato, M., CRITICAL POTENTIALS OF SOFT X-RAYS AND OF SECONDARY ELECTRONS FROM COPPER AND THEIR PHYSICAL SIGNIFICANCE.  
Sci. Rep. Res. Inst. Tohoku Univ. A5, 533-553 (1953).

1. Critical potentials for soft X-rays and for secondary electrons from copper, as determined by several workers, were discussed and corrections for their critical potentials were determined.
3. Tabulated results for critical potentials in copper are presented.
4. The critical potentials are explained as being the dissociation potentials of chained molecules of copper into component atoms, either with or without accompanying ionization.

1954

(1)T

Agarwal, B. K., A FORMULA FOR THE K AND L ABSORPTION DISCONTINUITIES.  
Current Sci. (India) 23, 357 (1954).

- 1,2,3. The general formula  $T_a = CZ^P\lambda^n$  was used to lead to the conclusion that the magnitude of

the K absorption jump ratio,  $R_K$ , is:

$$R_K = az^b$$

where  $\log_{10} a = 1.805283$  and  $b = -0.6207$ .

(2)E

Bedo, D. E. and D. H. Tomboulion, THE L ABSORPTION SPECTRUM OF SILICON AND SILICON DIOXIDE.  
Phys. Rev. 95, 621 (1954).

1. Si and SiO<sub>2</sub> were studied over a range of 60-200 Å.
2. Thin evaporated films were employed in a grating spectrometer.
3. The L<sub>2,3</sub> edge for Si is at 124.5 Å and the L<sub>2,3</sub> edge of SiO<sub>2</sub> is at 116.5 Å.
4. The energy gap in the semiconductor is about 0.8 eV.

(3)E

Blokhin, M. A., X-RAY K ABSORPTION OF TITANIUM IN BARIUM AND LEAD TITANATES. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 95, 965-968 (1954).

1. Ba and Pb titanates and TiO<sub>2</sub> and Ti<sub>2</sub>O<sub>3</sub> were investigated.
2. A bent crystal spectrograph was used; the Cu anode was covered with Bi-oxide for observational purposes.
- 3a. The separation from the 3d level to the edge is 5 eV.
- 3b. In BaTiO<sub>3</sub> there are 1s to 4sp bands for Ti<sup>3+</sup> and Ti<sup>4+</sup> in addition to a partially filled 3d band.
- 3c. The average number of electrons in a Ti ion is 0.35.
- 3d. The Ti and oxygen bonds are 25% covalent.
- 3e. The 4sp band separation between Ti<sup>3+</sup> and Ti<sup>4+</sup> is 4.5 eV.

(4)E

Blokhin, M. A., THE INFLUENCE OF TEMPERATURE AND PHASE TRANSFORMATIONS ON THE X-RAY ABSORPTION SPECTRUM OF TITANIUM IN BARIUM AND LEAD TITANATES. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 95, 1165-1167 (1954).

1. Ba and Pb titanates were studied between 25 and 200°C by observing their K X-ray absorption spectra.
2. A focusing spectrograph of the crystal type was used.
- 3a. The 3d absorption maximum is unaffected by temperature; however, elevation of the temperature shifts the complex absorption edge toward lower energies.
- 3b. The Ti<sup>4+</sup> 4sp absorption maximum decreases by 0.6 eV suddenly at the Ba titanate Curie point (128°C); this is explained by the transition from tetragonal to cubic structure.

(5)E

Brogren, G., A NOTE ON THE WIDTHS OF X-RAY EMISSION LINES.  
Arkiv Fysik 8, 391-400 (1954).

1. The Cu-K $\alpha_1$  width was studied in detail as were the widths of the K $\alpha$  in Ti, Fe and Mo.
2. A double crystal (quartz or calcite) spectrometer was used.



(5)E Cont'd.

- 3a. Line width was a function of the spectrometer resolving power; increasing the resolving power caused the line width to decrease asymptotically.

3b.	Element	$K\alpha_1$ Width (XU)
	Cu	0.43
	Ti	0.85
	Fe	0.80
	Mo	0.24

4. The true width is the difference of measured width and the width of the spectrometer diffraction pattern.

(6)E

Cauchois, Y., X-RAY SPECTRA AND CHEMICAL BONDING. J. Chim. Phys. (Paris) 51, 76-88 (1954). (In French.)

1. S in several inorganic compounds, Re in Re oxides, U in U oxides, Co in Co complexes, Al in  $Al_2O_3$ , and Al-Mg alloys were studied.
2. A bent crystal spectrometer was used and intensities were photographically recorded.
- 3a. Spectral shifts due to compound formation are tabulated and the author suggests some bonding schemes based on these data.
- 3b. Actual spectra are presented.

(7)E

Cauchois, Y., I Manescu and F. LeBerquier, THE L-SPECTRA OF PLUTONIUM. (In French.) Compt. Rend. (French Academy) 239, 1780-1782 (1954).

1. The L spectra of Pu in a 10 mg sample of  $PuO_2$  were obtained.
2. A bent crystal spectrograph was used and intensities were photographically recorded.
3. Spectra and tabular results are presented; a precision of better than 2 eV is claimed.

(8)T

Eisenlohr, H. and G. L. J. Muller, ANOMALOUS X-RAY SCATTERING OF HEAVY ATOMS IN THE REGION OF K AND L EDGES ACCORDING TO WAVE-MECHANICAL DISPERSION THEORY. (In German.) Z. Physik 136, 491-533 (1954).

1. Both the angular and frequency dependence for Ti, and only the frequency dependence for W were studied.
2. The treatment is Honl's procedure in which the radiation field of the scattering atom is developed in a series of multipoles and each is given a characteristic frequency dependence.
3. The influence of L electrons is great in a large region above the K edge.

(9)E

Faessler, A. and E. D. Schmid, STRUCTURE OF THE X-RAY K SPECTRUM OF SULFUR. (In German.) Z. Physik 138, 71-79 (1954).

1. Rhombic S, CaS, SrS,  $\alpha$ -MnS,  $K_2SO_4$ , and  $CaSO_4$  were studied.
2. A vacuum spectrograph was used and results were photographically recorded.
3. The spectrum consists of a broad band in the case of the element and the sulfide, but it is a very sharp line for the sulfates.
4. The K- $\beta$  spectrum cannot be treated as line displacements (such as the  $K\alpha$  doublet).

(10)E

Ferreira, J. G., CONTRIBUTION TO THE STUDY OF THE SATELLITE BAND INTENSITY OF THE  $L\alpha_1$  LINES FOR ELEMENTS OF ATOMIC NUMBER 73-92. (In Portuguese) Rev. Fac. Cienc. Univ. Lisboa 2, Ser. 3B-65-140 (1954).

1. Elements of atomic number 73-92 were investigated.
2. A curved crystal spectrometer was used and intensities were photographically recorded.
- 3a. The high frequency  $L\alpha_1$  line satellite increases with atomic number to a maximum at Tl and then decreases.
- 3b. The  $L\alpha_2$  line widths for these elements were also measured.

(11)E

Gyorgy, E. M. and G. G. Harvey, SPECTROSCOPY OF THE SOLID STATE: SOME OF THE TRANSITION ELEMENTS. Phys. Rev. 93, 365-369 (1954).

1. The  $3P_{3/2,1/2}$  (Valence to  $M_{2,3}$ ) emission bands of Ni, Mn, and Fe were obtained.
2. A glass grating spectrograph was used at grazing incidence; the bombarding voltage was 500 volts with a resultant target current of 4 ma and intensities were measured with a Be-Cu photomultiplier.
- 3a. All spectra and density of states curves for the elements studied are presented.
- 3b. 

Element	$3P_{1/2}$ emission edge $\pm 0.2$	$3P_{3/2,1/2}$ separation $\pm 0.1$	Bandwidth eV
Mn	46.8	0.6	$5.8 \pm 1.0$
Fe	52.3	0.6	$3.7 \pm 1.0$
Ni	66.7	0.9	$5.8 \pm 0.5$

(12)E

Johnston, R. W. and D. H. Tomboulion, ABSORPTION SPECTRUM OF BERYLLIUM IN THE NEIGHBORHOOD OF THE K EDGE. Phys. Rev. 94, 1585-1589 (1954).

1. The absorption spectrum of Be was studied in the spectral region 60-250A.
2. A grating spectrometer was used; the Be was irradiated with the bremsstrahlung from the Cornell synchrotron.
- 3a. Spectra and tabular data are presented.
- 3b. The mass absorption coefficient,  $\mu/\rho$ , varies from  $0.25 \times 10^5 \text{ cm}^{-1}$  to  $2.8 \times 10^5 \text{ cm}^{-1}$ .
- 3c. The absorption edge was found at 111A which is coincident with the emission edge.

(13)T

Jones, H., SOFT X-RAY EMISSION BANDS IN METALS.  
Phys. Rev. 94, 1072 (1954).

- 1,3. Excess bandwidths for Li, Na, and Al are tabulated.
2. The use of the Bohm-Pines treatment for valence band calculations rather than the Hartree-Fock method is suggested; a semi-empirical equation for excess bandwidth is given.

(14)T

Nigam, A. N., FINE STRUCTURE OF X-RAY ABSORPTION SPECTRA IN HOMOPOLAR CRYSTALS.  
Current Sci. (India) 23, 117-118 (1954).

1. The dissimilarities in X-ray absorption fine structure between two elements in the same crystal lattice were considered.
- 2,3. A proof of Kronig's suggestion that the fields around positive and negative ions in an ionic crystal give rise to different fine structures is presented in mathematical form.

(15)E

Parratt, L. G. and E. L. Jossem, X-RAY SPECTROSCOPY OF VALENCE AND CONDUCTION BANDS OF POTASSIUM CHLORIDE.  
Physica 20, 1135-1137 (1954).

1. The K $\beta$  emission bands in solid KCl were studied.
2. Crystal spectroscopy was used; the emission curves were recorded with high resolving power ( $\lambda/\Delta\lambda \approx 11,000$ ) and intensities were measured with a proportional counter.
- 3a. Corrected half-maximum widths of the 1s states are 0.33 eV for Cl - 3p and 0.22 eV for K - 3p.
- 3b. Spectra and an energy level diagram are presented.
4. Discrete atomic-like levels exist below the filled bands in the solid in the immediate neighborhood of the 1s vacancy.

(16)E

Parratt, L. G., THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF THE ATOMIC PHENOMENA OCCURRING ON AND NEAR THE SURFACES OF SOLIDS: I. SURFACE STUDIES OF SOLIDS BY TOTAL REFLECTION OF X-RAYS AND II. STRUCTURE OF THIN EVAPORATED COPPER FILMS BY TOTAL REFLECTION OF X-RAYS.  
Air Force Office of Scientific Research, Contract AF-18(600)-674 Tech. Rept. #1, AFOSR-TR-54-13, 68 pp. (1954).

- 1,2. Analysis of the reflected X-ray intensity vs. grazing angle curve was performed by extending dispersion theory to treat any small number of stratified homogeneous media.

- 3a. Such a plot for Cu evaporated onto glass was explained by assuming the air exposed (at 300° K) Cu is oxidized to a depth of 150A.
- 3b. If oxidation is less deep, there probably exists an electron density minimum just below an internal oxide seal.

(17)E

Rogers, J. L. and F. C. Chalkin, A GEIGER COUNTER VACUUM SPECTROMETER AND ITS USE FOR THE STUDY OF SOFT X-RAY LINES.  
Proc. Phys. Soc. (London) 67B, 348-356 (1954).

1. The M $\zeta$  line of Mo and the N doublet of W were studied.
2. The range of the instrument is 20-200A; the grating has 15,000 lines/inch and radiation is detected by means of a Geiger counter.
- 3a. Details of design and construction are given as are diagrams.
- 3b. X-ray line widths are discussed.

(18)E

Sakellariadis, P., THE L ABSORPTION AND EMISSION SPECTRA OF ERBIUM AND ITS ENERGY LEVELS.  
(In French.)  
Compt. Rend. (French Academy) 238, 2296-2298 (1954).

1. The absorption and emission L spectra of Er were measured.
2. A bent crystal (mica) spectrograph was used and intensities were photographically recorded.
3. Energy levels for Er are tabulated.

(19)E

Shinoda, G., T. Suzuki and S. Kato, ELECTRONIC SPECTROSCOPY IN THE SOFT X-RAY REGION.  
Tech. Repts. Osaka Univ. 4, 1-5 (1954).

1. This is chiefly a description of apparatus and technique although the L<sub>2,3</sub> spectrum of Al is shown.
- 2a. See Ref. #22-1956 for the method of photoelectronic spectrometry employed.
- 2b. Diagrams of the X-ray tube and circuit are given.
- 3a. Results for Al agreed with those made on a grating spectrometer.
- 3b. The photoelectronic method gives less resolution than the grating method.

(20)E

Shinoda, G., T. Suzuki and S. Kato, TWO TYPES OF BAND EMISSION CURVES FOR COPPER IN THE SOFT X-RAY REGION.  
Phys. Rev. 95, 840-841 (1954).

1. Emission spectra are obtained directly on an oscilloscope; the authors show actual oscillograms for the M<sub>2,3</sub> band of Cu.
2. Voltages applied to the anticathode are varied gradually and the soft X-rays emitted are detected with a photoelectric device; the resulting voltage vs. photocurrent curves are

(20)E Cont'd.

differentiated electronically.

3. The  $M_{2,3}$  band of Cu oscillated between a band of the shape of Skinner and a two-humped band corresponding to J. C. Slater's theoretical curve.

(21)E

Skinner, H. W. B., T. G. Bullen and J. E. Johnston, NOTES ON SOFT X-RAY SPECTRA, PARTICULARLY OF THE Fe GROUP ELEMENTS. Phil. Mag. (7) 45, 1070-1080 (1954).

1. Old unpublished work on Ca, Mn, Co, Ti, Cr, Fe, Ni, Cu,  $Cr_2O_3$ ,  $TiO_2$ , CaO, and  $MnO_2$  L and M bands is presented and compared with Gyorgy, Harvey's and Cauchois' results.
- 2a. Two grating spectrometers were used: one for M studies at 150-400A and the other for L studies at 13-40A.
- 2b. Targets were evaporated foils put down every 15-20 minutes during the long photographic exposures; the system was evacuated to  $10^{-6}$  mm Hg.
- 2c. The target power input was 600 watts (3kv and 200 ma).
3. All spectra are shown and a tabulation of  $L_3$  and  $M_3$  bandwidths for Ca, Ti, U, Cr, Mn, Fe, Co, Ni, Cu, and Zn is given.

(22)A

Smith, G. L. and L. G. Miller, MTR CRYSTAL SPECTROMETER AND DATA PRINTING SYSTEM. Phys. Rev. 96, 849 (1954).

1. This is a setup for a large computer installation.
2. Some 1500 separate measurements on 6-digit tape with 0.3% statistics and 106 counts per minute are accumulated.

(23)A

Tournaire, M., CORRECTION OF ERROR RESULTING FROM CONTINUOUS X-RAY RECORDING. (In French.) J. Phys. Radium 15, Suppl. to #1 - 16A-22A (1954).

1. The change in the line profiles during continuous automatic recording was studied analytically.
3. Corrections necessary to reconstruct a true profile were determined.

(C-1)T

Brown, E., CALCULATION OF ENERGY BANDS IN CRYSTALS. Univ. Microfilms PUBL 9735, 72 pp. (1954). Diss. Abs. 14 - 2096.

1. Electronic energy eigenvalues as a function of wave vector k for valence and conduction bands were calculated.
- 2a. The usual approximations leading to the one-electron Schroedinger equation in a periodic potential were made.
- 2b. The Schroedinger equation was replaced with

an equivalent variation principle and a solution was approximated by expansion in a finite number of plane waves plus an auxiliary function.

3. This led to a simple matrix equation for the coefficients.

(C-2)T

Craig, D. P., A. Maccoll, R. S. Nyholm, L. E. Orgel and L. E. Sutton, CHEMICAL BONDS INVOLVING d-ORBITALS. J. Chem. Soc. (London), 332-357 (1954).

1. Bonds which may require the use of d orbitals were investigated.
2. Overlap integrals involving 3s, 3p, 3d, and 4s orbitals are used as criteria for determining bond strengths.
- 3a. The results do not agree with those of Pauling.
- 3b. The importance of the conditional stability of d orbitals ( $\sigma$  and  $\pi$ ) resulting from the polar nature of bonds formed by s and p orbitals is stressed.

(C-3)T

Friedel, J., ELECTRONIC STRUCTURE OF PRIMARY SOLID SOLUTIONS IN METALS. Advances in Physics 3, 446-507 (1954).

1. A review of band structure calculations with 125 references is presented. Some of the topics reviewed are:
  - (1) The perturbed metallic lattice-insulators and metals.
  - (2) Self consistent solution in an alloy - screening, displacement of the Fermi surface.
  - (3) Molecular orbitals - overlapping bands, physical properties, Born approximation, parabolic and full bands.
  - (4) Atomic orbitals - X-ray and optical transitions.

(C-4)T

Herman, F., SOME RECENT DEVELOPMENTS IN THE CALCULATION OF CRYSTAL ENERGY BANDS - NEW RESULTS FOR THE GERMANIUM CRYSTAL. Physica 20, 801-812 (1954).

- 1,2. A Ge band structure calculation based on the orthogonalized plane wave method is presented.
- 3a. The band structure depends critically on the assumed crystal potential.
- 3b. A lowest conduction band minimum at positions along the [111] axis is predicted.

(C-5)T

Igo, G. and M. S. Wertheim, ISOTOPIC SHIFT IN THE X-RAY SPECTRA OF HEAVY ELEMENTS. Phys. Rev. 95, 1097 (1954).

- 1,3. Isotopic shifts in U, Pb and Mo are tabulated.
2. The Fermi-Thomas field approximation is used.



(C-6)T

Kiessling, R., THE NITRIDE, CARBIDE, BORIDE, AND SILICIDE OF TRANSITION METALS. (In German.) Fortschritt Chem. Forschung 3, 41-69 (1954).

1. Both binary and ternary systems are dealt with; bonding is discussed and illustrations given.
3. Metallic properties are associated with compounds having a value of 0.59 or less for the ratio of the atomic radius of the non-metal to that of the metal.

Note: 128 references are appended.

(C-7)T

Raimes, S., ENERGY BAND SHAPES AND BAND WIDTHS IN METALS. Phil. Mag. (7) 45, 727-734 (1954).

1. The Bohm-Pines density of states curve was compared with the Sommerfield and Hartree-Fock approximations for Na, Mg, and Al.
3. The Bohm-Pines curve shows a rudimentary tail but it is a great improvement over the Hartree-Fock method; however, the Bohm-Pines bandwidth is still much larger than the observed width.
4. This defect may be partially due to the neglect of the short range correlation energy.

(C-8)E

Roos, C. E., A NEW METHOD FOR MEASURING AUGER TRANSITIONS. Phys. Rev. 93, 401-405 (1954).

1. The K-fluorescence yield of Zr, Nb, Mo, Rh, Pd, Ag, Cd, and Sn was measured.
- 2a. X-rays were detected over a solid angle of  $2\pi$  steradians, the tube voltage was stabilized to 100 ppm, 35-40 kv at 10 ma was used. Radiation was passed through two sets of collimating slits and then to a NaI-Tl scintillation counter.

2b. Targets were 3 mm foils.

3.	Element	$\omega_K (\pm 3\%)$
	Zr	0.645
	Nb	0.713
	Mo	0.714
	Rh	0.779
	Pd	0.782
	Ag	0.814
	Cd	0.819
	Sn	0.840

(C-9)T

Shoemaker, D. P. and T. C. Huang, A SYSTEMATIC METHOD FOR CALCULATING VOLUMES OF POLYHEDRA CORRESPONDING TO BRILLOUIN ZONES. Acta Cryst. 2, 249-259 (1954).

1. The volume and number of quantum states in Brillouin polyhedra were calculated.
2. A geometrical treatment was employed.
3. The method was applied to cubic, tetragonal,

and orthorhombic systems and the results are shown.

(C-10)T

Slater, J. C. and G. F. Koster, A SIMPLIFIED LCAO METHOD FOR THE PERIODIC POTENTIAL PROBLEM. Phys. Rev. 94, 1498-1524 (1954).

- 1,2. It is proposed that various LCAO integrals be obtained as disposable constants; then one can force the LCAO results to agree with accurate results at symmetry points in the Brillouin zone.
3. Tables of matrix components of energy are given for all cubic structures.

(C-11)T

Wertheim, M. S. and G. Igo, ISOTOPE SHIFT IN THE X-RAY SPECTRA OF HEAVY ELEMENTS. Air Force Office of Scientific Research, Contract AF18(600)771, Tech. Rept. #8 AFOSR-TN-54-347, 16 pp. (1954).

1. Isotope shifts in the X-ray levels due to the nuclear volume effect were calculated for three different nuclear potentials.
- 2,3a. Screening effects of atomic electrons were accounted for by comparison of the Fermi-Thomas field wave function at the nuclear radius with that of a Coulomb field.
- 3b. An upper limit of the change in screening of other atomic electrons occurs when a K or L shell electron is removed or replaced.

1955

(1)T

Agarwal, B. K., PRESSURE OF ABSORBING GAS FOR OPTIMUM X-RAY ABSORPTION USE. (In English.) Z. Physik 142, 161-162 (1955).

- 1,4. For absorption experiments in the soft X-ray region, the following formula for gas pressure giving maximum intensity difference at absorption edge was deduced:  
$$Pd = AaZ^b \log a Z^b/Z (\mu_e)_K L (aZ^b-1)$$

P = density of absorber, A = atomic weight of absorber, d = thickness of absorber, Z = atomic number of absorber,  $(\mu_e)_K$  = absorption coefficient of 1 electron, L = Loschmidt's number,  $\log_{10} a = 1.80283$ ,  $b = 0.6207$ .
3. Pd for 0 = 0.79996, for N = 0.58173, for C = 0.39613.

(2)E

Amrehn, H. and H. Kulenkampff, ENERGY DISTRIBUTION IN SPECTRUM OF X-RAY BREMSSTRAHLUNG AS A FUNCTION OF THE ATOMIC NUMBER. (In German.) Z. Physik 140, 152-164 (1955).

1. Al, Ni, and Sn were observed at potentials of 25, 34, and 40 kv.
2. The direction of the proportional counter was 90° with respect to the electron beam.
3. Intensities were inversely proportional to the potential.

(3)E

Barinskii, R. L., X-RAY SPECTRA AND THE ELECTRONIC STRUCTURE OF THORIUM IN  $\text{Th}(\text{NO}_3)_4$  AND  $\text{ThO}_2$ . Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 133-135 (1955). (In Russian.) Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 20, 120-122 (1956).

1. The  $M_4$  and  $M_5$  absorption edge of Th in  $\text{Th}(\text{NO}_3)_4$  and  $\text{ThO}_2$  was studied.
2. A 500 mm radius quartz crystal spectrograph with a dispersive power of 9 eV/mm was used; intensities were recorded photographically, and the spectrograms were processed visually with a microphotometer.
3. The electronic structural changes were postulated from the spectra.
4. The results show that it is most "advantageous" for the electrons in the Th atoms to fill the 5f states first since the absorption lines in the  $M_4$  and  $M_5$  spectra are located energetically below all the other unoccupied levels of the Th atoms in the crystal.

(4)E

Beckman, O., RELATIVE INTENSITIES OF X-RAY K LINES OF HEAVIER ELEMENTS. Arkiv Fysik 2, 495-529 (1955).

1. Elements of atomic number 73-83, 90, and 92 were studied.
2. A Van de Graef generator was employed as a source of 800 kv exciting potential for use with a curved crystal (quartz) spectrometer giving a dispersion of 0.382 XU/mm.
3. Spectra and complete tabular results are given.

(5)T

Blokhin, M. A., INVESTIGATION OF THE DENSITY OF ELECTRONIC STATES IN A SOLID AND THE WIDTH OF THE INTERNAL ATOMIC LEVELS. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 142-151 (1955). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 20, 127-138 (1956).

1. A mathematical development is presented from which series functions can be deduced to correct distorted emission and absorption spectra obtained with a double crystal spectrometer to their true shapes.
- 3a. Corrections for K level width determinations in the iron group transition series are given.
- 3b. The application of these results to the density of states curve for nickel is discussed.

(6)E

Blokhin, M. A. and A. N. Gusantinski, SELECTION OF OPTIMUM SPECIMEN DENSITY FOR THE INVESTIGATION OF X-RAY ABSORPTION SPECTRA. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 128-133 (1955). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 20, 113-120 (1956).

1. Cu-Zn alloy specimens were studied in order

to determine the absorber thickness giving the greatest difference between the directly observed quantities on both sides of the absorption edge.

2. Ionization and photographic techniques were used.
3. Equations and conditions for using them in order to obtain optimum absorber densities under a variety of conditions are given.

(7)T

Cauchois, Y., ENERGY LEVELS FOR ATOMIC NUMBERS 2-69. (In French.) J. Phys. Radium 16, 253-262 (1955).

1. The energy levels were calculated from characteristic X-ray frequencies.
3. A table of energy levels for  $Z = 2-69$  is given.

(8)E

Cormack, D. V., J. E. Till, G. F. Whitmore and H. E. Johns, MEASUREMENT OF CONTINUOUS X-RAY SPECTRA WITH A SCINTILLATION SPECTROMETER. Brit. J. Radiol. 28, 605-609 (1955).

1. The spectral distribution of half-value layers of 1.7, 2.5, and 3.1 mm Cu strips was measured.
- 2a. A scintillation spectrometer was used.
- 2b. The spectral distributions were corrected for crystal and instrumental effects by comparison with spectra obtained with monochromatic radiation.
3. Corrected distributions are compared with those obtained by analysis of absorption data.

(9)E

Das Gupta, K., A. K. Sen and S. B. Bhattacharjee, STUDY OF CARBON  $K\alpha$  AND ALUMINUM  $L_{2,3}$  BANDS BY A NEWLY CONSTRUCTED SOFT X-RAY RULED GRATING SPECTROGRAPH. J. Sci. & Indust. Research (India) 14B, 129-130 (1955).

1. The content is primarily an equipment description.
- 2a. A 1-meter radius grating is used at a  $5.5^\circ$  grazing angle. An oxide coated Ni wire electron gun was used to excite the specimen.
- 2b. All vibration from the spectrograph was damped out.
- 2c. The target temperature was maintained at  $300^\circ\text{C}$  for 30 minutes before the sample was evaporated onto it.
- 2d. A 40-400 Å range is covered.
3. The  $L_{2,3}$  bandwidth of Al is 13.0 eV with an emission edge at 170.5 Å.

(10)E

Das Gupta, K. and E. Wood, SOFT X-RAY SPECTRA OF MAGNESIUM-ALUMINUM, MAGNESIUM-SILICON, AND ALUMINUM-SILICON ALLOYS. Phil. Mag. (7) 46, 77-86 (1955).

1. L spectra for the alloys were obtained; these were compared to the spectra from the respective pure elements.



(10)E Cont'd.

- 3a. The emission edge broadens on alloying.
- 3b. Structural changes in the shapes of the bands occur.
- 3c. No case of identity of the bands of the two constituents is found; this would be the case for a perfectly ordered single phase alloy.

(11)E

Ferreira, J. G., DETERMINATION OF THE INTENSITY OF  $L\alpha$  SATELLITE BANDS FOR  $Z = 73-92$ . (In French.) Compt. Rend. (French Academy) 241, 1929-1932 (1955).

- 1,2. A curved crystal (mica) spectrograph with a dispersion of 5.5 XU/mm was used to obtain the L spectra; intensities were recorded photographically.
- 3a. Results are presented as a table with satellite intensities shown as a percentage of the  $L\alpha_1$  primary maximum.
- 3b. A plot of satellite intensity versus atomic number rises to a maximum at  $Z = 83$  and then drops off.

(12)E

Fine, S. and C. F. Hendee, X-RAY CRITICAL ABSORPTION AND EMISSION ENERGIES IN eKV. Nucleonics 13, (3), 36-37 (1955).

1. Tables are given for  $Z = 1-100$ .
2. Values were obtained by a conversion of tabulated experimental wavelength values to keV using one of the following equations:  
 $E(\text{keV}) = 12.39644 \pm 0.00017/\lambda(\text{\AA})$  or  
 $E(\text{keV}) = 12.39644/1.002020 \lambda(\text{\AA})$

(13)E

Fobberth, O. G., SOLID SOLUTIONS IN  $A^{3B5}$  COMPOUNDS. (In German.) Z. Naturforsch. 10a, 502-503 (1955).

- 1,3.  $A^{3B5}$  forbidden band values are found.  $A^{3B5}$  compounds with values of forbidden band energy,  $\Delta E$ , between 0.33 and 1.25 eV and 1.45 - 2.22 eV were prepared.
2. Pseudobinary systems InAs-InP and GaAs-GaP form a complete series of solid solutions.

(14)E

Hempstead, C. F., LOCALIZED ENERGY STATES IN CRYSTALLINE ALKALI CHLORIDES BY SOFT X-RAY ABSORPTION SPECTROSCOPY. Univ. Microfilms, PUBL 10, 744, 108 pp. (1955). Diss. Abs. 15, 280 (1955).

1. The structure 20 eV from both sides of the K absorption edge of KCl and NaCl was investigated.
2. A double crystal (calcite) spectrometer having a resolution of 0.1 eV was used; a proportional counter was used to obtain intensity data.

- 3a. The structure observed is temperature sensitive and differs from NaCl to KCl.
- 3b. The inner vacancy resulting when a K-electron is photoejected causes a perturbation of the normal periodic potential in the vicinity of the ionized atom; this atom of atomic number  $Z$  appears as a  $Z + 1$  impurity in the solid.

(15)E

Herglotz, H., A NEW X-RAY MICROFOCUS TUBE. (In German, English summary.) Mikrochim Acta 1955, 684-695.

1. Secondary activation of  $\alpha_3$  satellites in Cr, and the chemical bonding influence on the  $K\beta_1$  line of Fe and Co in compounds were studied.
2. A tube with a radiating anode for convenient external excitation of X-ray spectra was used; the tube is diagramed and described.
3. The spectra of Al and  $Al_2O_3$  from 170-220A are shown.

(16)E

Kazantsev, V. A., INVESTIGATION OF THE X-RAY SPECTRA OF ALLOYS OF THE Mn-Ni SYSTEM. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 107-111 (1955). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 20, 97-102 (1956).

1. The  $K\beta_5$  lines during magnetic transformation over a range of 20-300°C were studied.
2. A curved crystal spectrometer was used and intensities were photographically recorded.
- 3a. The experimental results for all observed phenomena are listed.
- 3b. Transition to the paramagnetic state shifts the  $K\beta_5$  of Ni to higher energies and does the opposite to the  $K\beta_5$  of Mn.
4. A mechanism for the magnetic transition (based on the observed data) is postulated.

(17)T

Kurylenko, C., BRILLOUIN ZONES, ELECTRICAL CONDUCTIVITY OF METALS, AND X-RAY K ABSORPTION SPECTRA. (In French.) Cahiers de Physique 2, (54), 1-36 (1955).

1. The electronic properties of Cu, Ca, Ni, Al, Cr, Fe, K, Na, Li, Zr, Ag, In, W, Au, Mg, Zn, Sn, and Pb were studied.
- 3a. Many Brillouin zone diagrams and energy level diagrams are presented.
- 3b. A linear relationship was established between  $[(V_0 - \varphi) - E]_n$  and  $\log \sigma$  where  
 $V_0$  = mean potential in the crystal,  
 $\varphi$  = Richardson potential,  
 $E$  = maximum energy of levels occupied by free electrons,  
 $n$  = number of valence electrons,  
 $\sigma$  = electrical conductivity.

Landolt-Bornstein Tables - See Review (R-5).

(18)E

Mande, C., ON THE L-ABSORPTION SPECTRA OF GOLD IN THE PURE METAL AND IN GOLD-PALLADIUM ALLOYS. (In French.)  
Compt. Rend. (French Academy) 240, 1205-1207 (1955).

1. The L absorption of Au in pure Au and in two Au-Pd alloys was studied.
2. A curved crystal spectrometer was used and intensities were photographically recorded.
- 3a. The three L discontinuities are shifted to longer wavelengths, and the form of the  $L_3$  discontinuity is changed in the alloys.
- 3b.  $\nu/R$ ,  $E(eV)$  and  $\Delta E(eV)$  quantities are tabulated.

(19)E

Mande, C., THE L ABSORPTION SPECTRA OF GOLD IN GOLD-SILVER ALLOYS. (In French.)  
Compt. Rend. (French Academy) 240, 2222-2224 (1955).

1. The  $L_1$ ,  $L_2$ , and  $L_3$  absorption spectra in pure Au and in Ag - 50 w/o Au and Ag - 75 w/o Au were studied.
2. A bent crystal spectrograph was used and intensities were photographically recorded.
3. Values of  $\lambda(XU)$ ,  $\nu/R$  and  $E(eV)$  are tabulated for the observed features; the Au  $L_1$  and  $L_2$  absorption edges were displaced 1.2 eV and the  $L_3$  1.8 eV toward higher energies.

(20)E

Moore, H. R. and F. C. Chalkin, THE K SERIES EMISSION SPECTRUM OF NEON.  
Proc. Phys. Soc. (London) 68A, 717-725 (1955).

1. Tabular data and spectra for Ne are presented.
2. An electrodeless discharge source was used and spectra were photographically recorded with the aid of a bent crystal spectrometer.
- 3a. One diagram line, one semi-optical line, and twenty satellites were obtained.
- 3b. The shape of the diagram line and the satellite structure were analyzed.

(21)E

Narbutt, K. I., ON THE STRUCTURE OF X-RAY EMISSION LINES OF IONS IN SOLUTION. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 118-121 (1955).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 20, 107-110 (1956).

- 1,2. A special fluorescent spectrometer at 200 m $\mu$  and 50 kv was used to study the  $K\alpha$  lines of Zn in dissolved complexes by photographic means.
- 3a. Results of results and idealized spectra are presented.
- 3b. The  $K\alpha_1$  line for Zn ions in solution is broadened by a factor of 1.5 - 1.8 over Zn in solid compounds; the  $K\alpha_1$  is also highly asymmetric.
4. The  $L_{2,3}$  levels in Zn are split by the process of ionization.

(22)T

Nigam, A. N., THE ORIGIN OF FINE STRUCTURES IN X-RAY ABSORPTION SPECTRA OF IONIC SOLUTIONS.  
Proc. Phys. Soc. (London) 68B, 472-473 (1955).

1. The situation was examined from the point of view that an ion is confined for a short time in a potential space due to attraction on all sides which prevents the ion from escaping.
- 3a. The intensity distribution depends upon the dielectric constant of the solvent  $H_2O$  molecule.
- 3b. A table comparing the position of structures in solids and in solutions for several inorganic substances is presented.

(23)E

Nordfors, B., A NOTE ON  $Al-K\alpha_{3,4}$  LINES IN METAL AND OXIDE.  
Proc. Phys. Soc. (London) 68A, 654-656 (1955).

1. Wavelengths of  $K\alpha_{3,4}$  in Al and  $Al_2O_3$  are listed.
2. A curved crystal spectrometer evacuated to  $1 \times 10^{-5}$  mm Hg was used to study 20  $\mu$  layers and spectra were recorded with a Geiger counter.
3. Spectra and tables are shown.

(24)E

Parratt, L. G. and E. L. Jossem, X-RAY SPECTROSCOPY OF THE SOLID STATE: POTASSIUM CHLORIDE.  
Phys. Rev. 97, 916-926 (1955).

- 1,3. Emission and absorption data for K and Cl in solid KCl are presented and attempt to correlate the theoretical model was made.
- 2a. A double crystal (calcite) spectrometer was used in the (1,1) position and also a single crystal (mica) focusing spectrometer with a slit width of 0.1 XU.
- 2b. The vacuum was  $10^{-6}$  -  $10^{-7}$  mm Hg but there was still some contamination.
- 4a. The one-electron model is not valid for this case.
- 4b. It is possible that the strong emission line involving the valence band electrons does not, in general, give much information about the normal unperturbed valence band itself.

(25)E

Sakellaridis, P., EMISSIONS IN THE NEIGHBORHOOD OF ABSORPTION EDGES IN THE L REGION OF THE X-RAY SPECTRA OF RARE EARTHS. (In French.)  
J. Phys. Radium 16, 271-273 (1955).

1. Eu, Gd, Tb, Ho, and Tm in their trivalent oxide form were studied.
2. Used bent crystal spectrograph and results were photographically recorded.
3. The spectra are only discussed; no interpretation of them is offered.

(26)E

Sakellaridis, P., CHARACTERISTIC MULTIPLTS OF RARE EARTHS IN THEIR X-RAY EMISSION SPECTRA. (In French.)  
J. Phys. Radium 16, 422-427 (1955).

1. Eu, Gd, Tb, Ho, and Tm in their trivalent oxide form were studied.
2. A bent crystal spectrograph was used and results were photographically recorded.
- 3a. Characteristic anomalies due to the incomplete 4f shell were found.
- 3b. Tables and spectra showing the characteristic multiplets are presented.

(26)E Cont'd.

4. The results are not interpreted in detail.

(27)E

Sato, M., METHOD FOR ACCURATE DETERMINATION OF ABSOLUTE VALUES OF X-RAY LEVELS IN COPPER. Sci. Repts. Tohoku Univ. Series A-7, 56-66 (1955).

1. Evaporated thin films of Cu were investigated.
- 3a. Some 2.6 volts was found as the critical soft X-ray and secondary electron emission potential.
- 3b. Older work is tabulated and calculation and tabulation in terms of  $v/R$ , of the absolute X-ray levels, is presented.

(28)E

Sawada, M., K. Tsutsumi, I. Shiraiwa and M. Obashi, X-RAY NON-DIAGRAM LINES  $K\beta\eta$  and  $K\beta_L$  FROM  $Cr^{24}$  to  $Zn^{30}$ . J. Phys. Soc. Japan 10, 647-650 (1955).

1. The  $K\beta\eta$  and  $K\beta_L$  lines for  $Z = 24-30$  are tabulated.
2. A bent crystal (quartz) spectrograph was used and results were photographically recorded.
- 3a. The  $K\beta\eta$  line was resolved into two components; the longer wavelength line was  $K\beta_L$ .
- 3b.  $K\alpha$  is  $10^4$  as intense as  $K\beta\eta$  or  $K\beta_L$ .
- 4a. The  $K\beta\eta$  comes from  $KL_2 - L_1M_1$  and  $K\beta_L$  from  $K_3 - L_1M_1$ .
- 4n. The origin of  $K\beta\eta$  is ascribed to a two-electron jump ( $1s2p$ ) and ( $2s3s$ ).

(29)E

Shinoda, G., SOFT X-RAY SPECTRA DUE TO ENERGY BANDS IN THE SOLID STATE. (In Japanese.) X-Sen (X-rays) 8, 55-60 (1955).

1. The L and M spectra of Cu, Ni, Mn, Fe, and  $CuAl_2$  were studied.
2. The photoelectric method described in Ref. #22 (1956) was used.
- 3a. Values of  $\lambda$ ,  $v/R$ , and energies for Cu -  $L_1$ ,  $L_2$ ,  $L_3$  and  $M_{2,3}$  and for Ni -  $L_3$ ,  $M_{2,3}$  are tabulated.
- 3b. Actual oscillograms for the Cu -  $M_{2,3}$  are presented showing a double peaked curve and a single peaked curve which alternate, one dissolving into the other.
- 3c. The grating and photoelectric methods are compared; the photoelectric method is virtually as good as that of the grating.

(30)T

Sokolov, A. V., ON THE ABSORPTION AND EMISSION OF X-RAYS BY FERROMAGNETIC METALS. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 113-117 (1955). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 20, 103-107 (1956).

- 1,2. A model of exchange interaction between the outer s electrons and inner d electrons was used to compute the density of states curve.

- 4a. The existence of quasi-particles which are essentially elementary excitations is postulated.
- 4b. The density of conduction electron states is a quadratic function of spontaneous magnetization.

(31)E

Sprague, G., D. H. Tomboulion and D. E. Bedo, CALCULATIONS OF GRATING EFFICIENCY IN THE SOFT X-RAY REGION. J. Opt. Soc. Am. 45, 756-761 (1955).

1. Expressions for predicting the energy distribution among spectral orders produced by a grating near grazing incidence were derived.
2. Theoretical calculations were checked by means of a 30,000 lines/in. grating at a grazing angle of  $4.64^\circ$ .
- 3a. Curves for the reflecting power as a function of wavelength for an unblazed glass grating are presented.
- 3b. Grating interference conditions, phase amplitude relations, and boundary conditions are discussed.

(32)E

Tomboulion, D. H., ON THE SPECTRA AND ANGULAR DISTRIBUTION OF ULTRAVIOLET RADIATION FROM THE 300 MEV CORNELL SYNCHROTRON. U.S. At. Energy Comm. NP-5805, 16 pp. (1955).

- 1,2. A grazing incidence spectrograph was used to record the power spectrum in the 60-450A region; the results were recorded photographically.
3. The use of the continuous synchrotron radiation as a source for absorption measurements in the extreme ultraviolet is suggested.

(33)E

Tomboulion, D. H., THE EXTREME ULTRAVIOLET SPECTRA OF SOLIDS. U.S. At. Energy Comm. NP-5803, 24 pp. (1955).

- 1,2a. A grazing incidence grating vacuum spectrograph was used to study the absorption spectra of Be, BeO, Si, SiO, SiO<sub>2</sub>, P, S, Cr, Mn, Ni, and Ge in the spectral region 60-450A.
- 2b. A synchrotron power spectrum was used as the source of continuous radiation.
3. Results are presented graphically at various wavelength positions.

(34)E

Tomboulion, D. H. and D. E. Bedo, METAL FOILS AS FILTERS IN THE SOFT X-RAY REGION. Rev. Sci. Instr. 26, 747-750 (1955).

1. Evaporated foils, 500-2000A thick, of Be, Mg, and Al were used as filters in the 50-500A region.
2. Procedures for the preparation of plastic backing films (Zapon, Formvar, Mylar, etc.) are outlined.
3. Absorption curves for Be, Mg, Al, and Zapon vs. wavelength are shown in order that one may choose the proper filter and thickness.
4. Filters may be used to exclude visible light, sort out overlapping orders, and to transmit narrow bands of radiation by reducing the



(34)E Cont'd.

intensity of undesirable portions of the spectrum.

(35)E

Vainshtein, E. E., REGULARITIES IN THE STRUCTURE OF THE MAIN X-RAY ABSORPTION OF ATOMS OF ALKALI HALIDES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 105, 1196-1199 (1955).

1. The K absorption of potassium in KCl, KBr, KI, and KF was measured.
2. A curved crystal spectrometer was used and intensities were photographically recorded. Spectra were corrected for the irregular intensity distribution of the continuous spectrum.
3. The K absorption spectrum for KF differed from that of the other halides greatly.
4. No reasons for this difference are given, but it is proposed that the difference is of a qualitative nature.

(36)E

Vainshtein, E. E., THE FINE STRUCTURE OF K LINES OF THE TITANIUM SPECTRUM IN DIELECTRICS. Doklady Akad. Nauk S.S.S.R. 105, 943-946 (1955). (In Russian.)

1. Preliminary work on  $TiO_2$ , ilmenite, and perovskite is presented. See Ref. #25 (1956) for results.

(37)E

Van Den Berg, C. G. and H. Brinkman, HIGH LUMINO-SITY SPECTROMETRY IN THE SOFT X-RAY REGION. I. THE CYLINDER SPECTROMETER. Physica 21, 85-102 (1955).

1. Complete calculations for the design of a crystal spectrometer are given.
2. A mica crystal was bent to a cylindrical shape and the spectra were observed along the cylinder axis; the radius of curvature was 200 mm and the reflecting surface was 14 x 4 cm (56 sq. cm.).
- 3a. The intensity gain was 60-90 over other crystal spectrometers; the wavelength range is 9 - 19A.
- 3b. Spectra for W, Cl, and Si are presented.

(38)E

Wagner, B., H. Witte and E. Wolfel, X-RAY DETERMINATION OF THE ELECTRON DISTRIBUTION IN CRYSTALS: I, II. (In German.) Z. Physik Chem. 3, 273-329 (1955).

1. The energies of X-rays reflected by the crystal were measured.
2. These energies were recorded on moving photo-sensitized paper with a 1-2% error.
3. The results for rock salt were 10.05 electrons for  $Na^+$  and 17.70 electrons for  $Cl^-$  ions.

(39)E

Woodruff, R. W. and M. P. Givens, SOFT X-IRRADIATION OF Te THIN FILMS. Phys. Rev. 97, 52-54 (1955).

1. The linear absorption coefficient of Te was measured from 100-400A.
2. A grating spectrometer evacuated to  $5 \times 10^{-5}$  mm Hg was used.
- 2b. The radiation source was a spark caused by a capacitor (0.15 $\mu$ f) charged to  $3 \times 10^4$  volts between Ag or Cu electrodes.
- 3a. A large peak at 155A was observed.
- 3b. A double peak was observed at 300A.
4. The double peak was due to  $N_4$  and  $N_5$  transitions to the conduction band.

(C-1)T

Candlin, D. J., ON THE IDENTIFICATION OF X-RAY SATELLITES. Proc. Phys. Soc. (London) 68A, 322-328 (1955).

1. The wave numbers of  $K\alpha$  sets for  $Z = 19-42$  were calculated.
2. Analytical wave functions were used.
3. Transitions are listed and results are tabulated.

(C-2)T

Dehlinger, U., H. Schenk and W. Weser, BONDING IN METALLIC PHASES. (In German.) Z. Metallkunde 46, 647-650 (1955).

1. Ga,  $MoSi_2$ , diamond, Zn, As, Bi, Sb, and  $WSi_2$  were studied.
- 3a. Band structures for As and Sb are presented.
- 3b. Bonding is examined by Bloch theory and also by Sommerfeld-Gramm theory.

(C-3)T

Koster, G. F. DENSITY OF STATES CURVE FOR NICKEL. Phys. Rev. 98, 901-902 (1955).

- 1,3. The density of states curve for Ni was extended over the entire energy range of the "d" bands.

(C-4)T

Laskar, W., LINE WIDTHS FROM DIPOLE AND QUADRUPOLE TRANSITIONS. (In French.) J. Phys. Radium 16, 644-649 (1955).

1. Radiative line widths and intensities were calculated.
3. Transition probabilities for the K,  $L_1$ ,  $L_2$ ,  $L_3$  levels of Bi, Pb, Pt, and W are tabulated.

(C-5)T

Lewis, M. N., L. C. Green, M. M. Mulder, and P. C. Milner, COMPUTED TRANSITION PROBABILITIES FOR X-RAY CONTINUA OF POTASSIUM. Phys. Rev. 98, 1020-1028 (1955).



(C-5)T Cont'd.

1. The moment, momentum, and acceleration matrix elements for K were computed.
2. Hartree-Fock one-electron wave functions were used.
- 3a. All data are tabulated.
- 3b. The momentum matrix element gives the best values as compared with experiment.

(16 sparks/minute).

- 3a. Actual spectra and band shapes are shown.
- 3b. The  $L_{2,3}$  edge of Si is at 123A and the  $M_{2,3}$  edge of Ge is at 101.5A.
- 3c. For Si and Ge  $\mu/\rho$  is  $1.4 \times 10^5 \text{ cm}^{-1}$  and  $1.8 \times 10^5 \text{ cm}^{-1}$  respectively.
- 3d. The range of forbidden energies is 1.0 eV for Si and 0.8 eV for Ge.
4. Valence bandwidths are 16.7 eV for Si and 7.0 eV for Ge.

(2)T

Brentano, J. C. M., THE CYLINDER X-RAY SPECTROMETER. *Physica* 22, 705-706 (1956).

- 1,2. A discussion is given of a mica crystal spectrometer for the soft X-ray region in which the crystal is bent to a cylindrical radius.
3. Details for alignment of such a spectrometer are given.

(C-6)T

Rubenstein, R. A. and J. N. Snyder, NEW TREATMENT OF THE AUGER EFFECT AND THE FLUORESCENCE YIELD IN THE LIGHTER ELEMENTS. *Phys. Rev.* 97, 1653 (1955).

- 1,2 The yield,  $\psi_k$ , was computed from transition rates.
3. The yield,  $\psi_k$  for A, Kr, and Ag were 0.13, 0.67, and 0.85 respectively. This compares favorably with experimental data.

(3)E

Carter, D. E. and M. P. Givens, SOFT X-RAY ABSORPTION OF THIN FILMS OF IRON AND IRON OXIDE. *Phys. Rev.* 101, 1469-1472 (1956).

1. The absorption of thin (about 440A) films of Fe and  $\text{Fe}_2\text{O}_3$  between 170 and 340A was studied.
- 2a. A 2 m grating (30,000 lines per inch) spectrograph with a grazing angle of  $5^\circ$  was used; spectra were recorded photographically; the vacuum was  $5 \times 10^{-5} \text{ mm Hg}$ ; slit width was 0.03mm.
- 2b. The radiation source was a Cu spark operated in vacuo with a DC voltage of 30,000 volts; sparking rate was 1000 per hour.
- 3a. The Fe edge is 225A and the  $\text{Fe}_2\text{O}_3$  edge is 218A.
- 3b. Spectra are shown and a density of states curve for Fe is postulated.

(C-7)T

Slater, J. C., ONE ELECTRON ENERGIES OF ATOMS MOLECULES AND SOLIDS. *Phys. Rev.* 98, 1039-1045 (1955).

1. Tables of ionization energies of the atoms and of revised X-ray term values are presented.
3. The Fermi surface in alkali metals was found.

(4)E

Cauchois, Y., SPECTRAL DISTRIBUTION IN THE REGIONS OF CHARACTERISTIC ABSORPTION OF VARIOUS CRYSTALS. (In French.) *Compt. Rend. (French Academy)* 242, 100-102 (1956).

1. Anomalous absorption and stray line effects in quartz, mica, and gypsum were studied.
2. The crystals from a bent crystal spectrograph were used.
3. The anomalies were due to heavier atom impurities such as Al and Si in mica, Si in quartz, and S and Ca in gypsum.

(5)E

Cauchois, Y. and I. Manescu, THE FLUORESCENCE SPECTRUM OF PLUTONIUM. (In French.) *Compt. Rend. (French Academy)* 242, 1433-1436 (1956).

1. Some twenty lines of the Pu spectrum were measured.
2. A curved crystal spectrograph was used and intensities were photographically recorded.
3. Wavelength positions of the lines are tabulated.

(6)T

Cotton, F. A., and C. J. Ballhausen, SOFT X-RAY ABSORPTION EDGES OF METAL IONS IN COMPLEXES. I. THEORETICAL CONSIDERATIONS.

(C-8)T

Wolfsberg, M. and M. L. Perlman, MULTIPLE ELECTRON EXCITATION IN AUGER PROCESSES. *Phys. Rev.* 99, 1833-1835 (1955).

1. The work was done on chlorine atoms.
- 3,4. The atom gets a greater charge from an Auger cascade than that obtainable by conventional two-electron theory.

1956

(1)E

Bedo, D. E. and D. H. Tomboulion, STUDY OF SILICON AND GERMANIUM IN THE SOFT X-RAY REGION. *Phys. Rev.* 104, 590-597 (1956).

1. Absorption spectra of thin evaporated foils in the spectral region 70-200A and emission spectra of Ge in the 60-600A region are presented; absorbers were several hundred to several thousand ( $\pm 10\%$ ) angstroms thick.
- 2a. A grating spectrometer at a pressure of  $10^{-6} \text{ mm Hg}$  was used.
- 2b. Absorption procedures are described as well as the spark rate used as a "light" source

(6)T Cont'd.

J. Chem. Phys. 25, 617-619 (1956).

1. The effect of crystal field symmetry and bond type on the appearance of K X-ray absorption edges of metal ions in complexes is considered.
2. In complexes where the interaction of the metal ion and ligands can be regarded as primarily ionic, an adequate description of the essential features of the fine structure of the edge may be obtained by considering the crystal field splitting of the p orbitals of the metal ion.
3. The splitting of the  $1s-4p$  absorption for first row transition elements is related to the splitting of the degeneracy of the  $4p$  energy levels in the ion by the crystal field.

(7)E

Cotton, F. A. and H. P. Hanson, SOFT X-RAY ABSORPTION EDGES OF METAL IONS IN COMPLEXES. II. CuK EDGE IN SOME CUPRIC COMPLEXES.  
J. Chem. Phys. 25, 619-623 (1956).

1. X-ray absorption measurements were made on salts and solutions of copper complexes in the region of the K absorption edge.
2. A double crystal (calcite) X-ray spectrometer was used. The  $(1, -1)$  width at the  $CuK\alpha$  line was slightly less than a volt. The data were taken with a commercial end-window Gieger tube and recorded by a decade scaling unit. A water-cooled tungsten target X-ray tube, supplied by a 10 KVA stabilized AC source was used.
3. It is shown that the crystal field splitting of the  $4p$  orbitals of  $Cu(II)$  in some complexes can be correlated with the splitting of the  $1s-4p$  transition observed in studies of the K absorption edges of these complexes, provided the ligand-metal bonding is not appreciably covalent.
4. The results obtained are in agreement with the theory developed in part I of this paper (preceding abstract).

(8)E

Das Gupta, K., ELECTRON TRANSFER SMEKAL LINES IN X-RAY SCATTERING ON THE LONG AND SHORT WAVELENGTH SIDE OF THE MONOCHROMATISED INCIDENT X-RAY BEAM.  
Science and Culture (India) 21, 624-626 (1956).

1. The scattering of weak X-rays by Si, Na, Al, and oxygen excited by  $Cu-K\alpha$  radiation was studied.
2. A bent crystal (mica) spectrograph was used and intensities were photographically recorded.
- 3a. Smekal lines were clearly present on both the long and short wavelength sides of the incident radiation.
- 3b. Smekal positions are tabulated.

(9)E

Deodhar, G. B. and R. C. Karnatak, THE L-EMISSION SPECTRUM OF  $Sm^{62}$ .  
J. Sci. & Indust. Research (India) 15B, 615-618 (1956).

1. The spectra (L emission) of  $Sm^{62}$  are presented.
2. A transmission curved crystal (mica) spectrometer was used and spectra were photographi-

cally recorded.

- 3a. Lines at 1.7 and 1.8A from  $L_{2:04}$  and  $L_{3:04,5}$  transitions respectively were found.
- 3b. Derived energy levels are tabulated.
4. The 1.7 and 1.8A lines indicate an  $04,5$  level.

(10)T

Fujimoto, H., K ABSORPTION SPECTRUM OF METALLIC Al.  
Sci. Repts. Tohoku Univ. First Ser. 39, 189-193 (1956).

1. Theoretical absorption maxima for metallic Al are derived and tabulated, and previous experimental results are tabulated.
3. Widths of the quasi-stationary states in Al were calculated and tabulated.
4. From these calculations an attempt was made to resolve the maxima into individual absorption bands.

(11)E

Gale, B. and J. Trotter, SOFT X-RAY SPECTRA OF SOLID SOLUTIONS OF ALUMINUM AND MAGNESIUM.  
Phil. Mag. (8) 1, 759-770 (1956).

1. The  $L_{2,3}$  bands of Al-Mg alloys were examined.
2. A grating spectrometer evacuated to  $10^{-5}$  mm Hg was used and spectra were photographically recorded.
- 3a. The widths and shapes of the solute bands in the alloys differed greatly from those of the solvents and pure metals.
- 3b. These changes were examined in the light of the Thomas-Fermi treatment of fields around impurity atoms.
- 3c. The spectra for the alloys are presented.

(12)E

Kamada, O., SPECTRAL INTENSITY DISTRIBUTION OF BREMSTRAHLUNG.  
Sci. Repts. Tohoku Univ. First Ser. 40, 152-160 (1956).

1. Using only a W target, the spectral intensity for a condenser discharge tube was derived.
3. Curves for the distribution based on the formulae of Nicholas and of Kulenkampff are presented.
4. Extension of these formulae into the soft X-ray region was assumed.

(13)E

Karal'nik, S. M., X-RAY SPECTRA AND INTERATOMIC BONDS IN ALLOYS. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 815-819 (1956).

1. Alloys of Fe-Cr, Co-Cr, Ni-Cr, and Ni-Mn were studied.
2. A crystal spectrograph was used.
3. The K absorption edge of the metals in the alloys is shifted toward shorter wavelengths as compared to the parent metals.
4. This shift is due to an increase in the interatomic bond strength on alloying.

(14)T

Karal'nik, S. M., ASYMMETRY OF  $K\alpha_{1,2}$  LINES AND THE INTERATOMIC BOND IN METALS AND ALLOYS OF THE IRON GROUP. (In Russian.)  
Nauk Providomlennya Kiev Univ. 1956 #1, 41-42.  
Annotation from Referat. Zhur. Met. 1957  
Abstr. 8635. (In English.)

- 1a. It was postulated that bonding exists by degrees and examination of  $K\alpha$  lines on this basis was undertaken.
- 1b. The index of asymmetry rises in transition metals up to iron and then decreases; the index also changes on alloying.
3. These asymmetry effects are explained by the screening of K electrons by outer electrons in the interatomic bond.
4. The stronger the interatomic bond the less the screening effect, this causes the  $K\alpha_{1,2}$  lines to adopt a position more towards short wavelengths than the position for weaker bonding.

(15)E

Kazantsev, V. A., BEHAVIOR OF THE  $K\beta$  GROUP X-RAY SPECTRA IN THE Fe-Cr SYSTEM. (In Russian.)  
Sbornik. Nauch. Trudov. Kuibyshev. Ind. Inst. 2, 187-190, (1956).  
Annotation from Chem. Abs. 53, 850a.

1. The  $K\beta$  group in Fe-Cr alloys containing 11.4-14.23% of Fe was studied.
2. Primary excitation in a crystal spectrometer was employed; intensities were recorded photographically.
- 3a. The  $K\beta_1$  wavelength of Fe and Cr in ferromagnetic alloys is independent of composition, while in the paramagnetic state the Fe- $K\beta_1$  is unchanged but the Cr- $K\beta_1$  increases to 0.53 XU.
- 3b. The  $K\beta_5$  zone width for Fe and Cr varies discontinuously on transition into the paramagnetic region.
4. Complete pooling of electrons does not occur in Fe-Cr alloys.

(16)E

Kiyono, S.,  $K\beta$  LINES OF POTASSIUM IN COMPOUNDS.  
Sci. Repts. Tohoku Univ. First Ser. 39, 129-144 (1956).

1. Crystalline KCl, KBr, KI,  $K_2CO_3$ , and  $K_2SO_4$  were studied.
2. A bent crystal (50 cm radius quartz) spectrograph with a Sandstrom (dry air discharge) tube, was used to make 50 hour photographic exposures with a dispersion of 5.2 eV/mm.
3. With fresh compound being added every 1-2 hours,  $\lambda$  and  $\Delta\lambda$  of the  $K\beta_1$  were measured and from these  $\nu/R$ ,  $\Delta\nu/R$ , &  $\Delta\nu$  are calculated and tabulated; all other results from 1914-1955 are also tabulated for comparison.
4. The wavelength of the  $K\beta_5$  changes slightly with compounding, but the other lines appeared to be independent of crystal structure or form.

(17)E

Kotlyar, B. I., INVESTIGATION OF ASYMMETRY AND WIDTH OF  $K\alpha_1$  LINES OF Cu AND Mn IN GEISLER ALLOYS. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 20, 790-793 (1956).

1. The asymmetry of the  $K\alpha_1$  line of Cu and Mn was examined in ferromagnetic Cu-Mn-Al alloys and paramagnetic Cu-Mn alloys.
2. Measurements were made with a demountable X-ray tube at 50-700°C.
- 3a. The asymmetry index differed with magnetic state and increased with temperature.
- 3b. The width of the  $K\alpha_1$  lines remained the same when the magnetic state was changed.

(18)E

Noble, R. and L. Jacob, CONTINUOUS INTENSITIES IN THE SOFT X-RAY REGION.  
Nature 178, 814 (1956).

1. The relationship  $I = kZV^2$  (constant current) was investigated in the 13-62A range (200-8000V).
2. The C and Cu targets were outgassed at red heat in vacuo, a 15 stage Be-Cu photomultiplier was used to count photons, and reproducible results were obtained.
3. Results showed that for any fixed voltage, the X-ray output is directly proportional to the current, but for fixed current, the output is approximately proportional to the first power of the voltage.

(19)E

Nordfors, B., THE K SPECTRUM OF Al AND ITS OXIDES.  
Arkiv Fysik 10, 279-289 (1956).

1. The  $K\alpha_1$ ,  $K\alpha_2$ ,  $K\alpha_3$ ,  $K\alpha_4$ , and  $K\beta$  for Al and its oxides were recorded.
- 2a. An X-ray tube was constructed with 2 targets in order to obtain suitable reference lines.
- 2b. Difficulty in keeping the Al target oxygen-free was encountered.
3. A change in the intensity and line shape of the satellites  $\alpha_3$  and  $\alpha_4$  in the oxide as compared to the metal was found.

(20)E

Sen, A. K.,  $L_{2,3}$  AND K EMISSION SPECTRA FROM Mg, Al, AND Li.  
Indian J. Phys. 30, 415-422 (1956).

1. The band width band structure and edge breadths were determined in Mg, Al, and Li; the data agree with those of Skinner.
2. A 1 meter grating with 1152 lines/mm was used at a grazing angle of  $5.5^\circ$  with a slit width of 0.02-0.03 mm. The intensities were photographically recorded; the evaporated specimen is excited with a 3 kv beam of electrons. All operations were carried out at a pressure of  $10^{-5}$  mm Hg.



(20)E Cont'd.

- 3a. Spectra and tabular results are presented.
- 3b. The position of the Fermi surface based on the data obtained is discussed.

Shaw, C. H., - See Review (R-13) and (R-14).

(21)E

Shaw, C. H., SOFT X-RAY SPECTRA OF METALS AND ALLOYS.  
U.S. At. Energy Comm. AECU-3578, 81 pp.(1956).

1. Characteristic emission and absorption spectra of Ti, Zr, Hf, Th, and their alloys are presented.

(22)E

Shinoda, G., T. Suzuki and S. Kato, THE SOFT X-RAY SPECTROSCOPY OF THE SOLID STATE BY THE ELECTRONIC DIFFERENTIATING METHOD: ALUMINUM L<sub>3</sub>.  
J. Phys. Soc. Japan 11, 657-661 (1956).

- 1,3a. The Al-L<sub>3</sub> was studied; a bandwidth of 10.5 eV was obtained.
- 2a. A photoelectronic spectrometer in which soft X-rays are detected by a photosensitive surface (copper sheet in this case) was used with a retarding potential having a sawtooth waveform (100 cps). Photoelectric currents on the order of 10<sup>-9</sup> to 10<sup>-12</sup> amperes were electronically differentiated 3 times in order to represent the intensity of soft X-ray emission (the sawtooth voltage corresponds to reciprocal wavelength).
- 2b. The differentiated current was placed on an oscilloscope, thus giving the band structure in 0.01 second.
- 3b. The resolving power of this method vs. the grating method is shown; the latter is better up to 225A.
- 3c. The tube and circuit are diagramed and an actual oscillogram of the Al-L<sub>3</sub> is presented.

(23)E

Trapneznikov, V. A. and S. A. Nemnonov, BOND STRENGTH IN Fe-Mo SOLID SOLUTIONS FROM THE FINE STRUCTURES OF X-RAY ABSORPTION SPECTRA. (In Russian.)  
Fiz. Metal. i Metallovedne 3, 314-320 (1956).

1. The K absorption spectra of Fe alloyed with 0, 0.5, 1.0, 2, and 4% Mo, pure Co, and Ni were studied over a temperature range of 20-800°C.
2. Bent crystal spectrography was used.
- 3a. At 20°C the amplitude fluctuation ratio of fine structure absorption limits as a function of concentration (AFR f(C)) begins to increase at 1% Mo - increases from 1-2% Mo and then remains essentially constant to 4% Mo.
- 3b. At higher temperatures, the bond strength of Fe-Mo alloys is greater than that of Fe.
4. The AFR f(C) is a measure of the bond strength between the atoms involved.

(24)E

Trapneznikov, V. A., THE K ABSORPTION EDGE POSITION IN Fe AND Ni FOR PURE METALS IN FERROMAGNETIC AND PARAMAGNETIC STATES.  
Fiz. Metal. i Metallovedne 3, 561-562 (1956).

- 1,2. A vacuum X-ray spectrograph with a linear dispersion of 2.45 XU/mm and 3.87 XU/mm for Fe and Ni respectively was used.
3. A point 'b' was defined as the Fermi surface; no change in this point was observed on passing through the Curie point of Fe and Ni.
4. The Fermi surface position is fixed in this transformation of Fe and Ni.

(25)E

Vainshtein, E. E., THE K SERIES IN TITANIUM METAL AND IN SOME DIELECTRIC MATERIALS. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz 20, 784-789 (1956).

1. The fine structure in the K absorption spectrum of Ti in Ti metal, TiO<sub>2</sub>, ilmenite and perovskite was studied.
2. A bent crystal (quartz) spectrograph was used and intensities were photographically recorded.
- 3a. The K  $\alpha$  width was unchanged, but the K $\beta$  is 30% broader in the compounds and a satellite K $\beta$ " was present in the compounds but absent in the metal.
- 3b. The asymmetry index was 1.19 in compounds and 1.42 in the metal.
4. The K $\beta$ " satellite was attributed to transitions from the '0' level to the free K level in the Ti atom.

(26)E

Vainshtein, E. E. and B. I. Kotlyar, X-RAY EMISSION SPECTRA OF Mn AND Cu IN HEUSLER ALLOYS IN THE MAGNETIC TRANSITION TEMPERATURE RANGE. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 110, 44-47 (1956).  
Trans: Sov. Phys. "Doklady" 1, 527-529 (1956).

1. The K $\alpha$ <sub>1,2</sub> lines and the K $\beta$  group in Cu and Mn in the alloy Cu<sub>2</sub>MnAl were studied over a temperature range of 40-300°C.
2. A curved crystal (quartz) spectrograph having a dispersive power of 2-3.8 XU/mm was used; intensities were recorded photographically.
- 3a. Spectra and a plot of the K $\alpha$ <sub>1</sub> and K $\alpha$ <sub>2</sub> lines of the Mn asymmetry index vs. temperature are presented.

	Magnetic State			
	Ferromagnetic		Paramagnetic	
	$\lambda$ (XU)	E(eV)	$\lambda$ (XU)	E(eV)
MnK $\beta$ <sub>1</sub>	1906.12	6463.48	1906.15	6463.37
MnK $\beta$ <sub>5</sub>	1892.93	6508.52	1893.30	6507.30
CuK $\beta$ <sub>1</sub>	1389.42	8867.15	1389.38	8867.41
CuK $\beta$ <sub>5</sub>	1378.55	8937.22	1378.48	8938.09

(C-1)E

Amrehn, H., ENERGY DISTRIBUTION IN SPECTRUM OF X-RAY BREMSTRAHLUNG AS A FUNCTION OF THE ATOMIC NUMBER. (In German.)  
Z. Physik 144, 529-537 (1956).

1. C, Al, Ni, Ag and Au were studied at potentials of 25, and 34 kv.



(C-1)E Cont'd.

2. The direction of the observational proportional counter was  $90^\circ$  with respect to the electron beam.
3. Results agreed satisfactorily with Sommerfeld Theory.

(C-2)T

Biberman, L. M. and E. M. Novodvorskaya, THE EFFECT OF REABSORPTION ON SPECTRAL LINE WIDTH. (In Russian.) Doklady Akad. Nauk S.S.S.R. 106, 35-38 (1956).

1. An equation expressing the width ( $\omega$ ) of a spectral line in the presence of a Doppler effect was derived.
- 3a. The equation is:

$$\omega = 2 \sqrt{\ln 2} \left[ \frac{\nu - \nu_0}{\Delta \nu_D} \right]$$

$\nu_0$  is the emission frequency.

$\nu$  is the frequency of the center of the line.

$\nu_D$  is the Doppler frequency.

- 3b. Comparison with other Russian experimental data was favorable.

(C-3)T

Blokhin, M. A., TRUE SHAPE OF X-RAY SPECTRA. Doklady Akad. Nauk S.S.S.R. 107, 33-36 (1956). Trans: Sov. Phys. "Doklady" 1, 145-148 (1956).

- 1,2,3. A correction scheme for spectra obtained with a double crystal spectrometer was postulated; the scheme assumed a dispersion function for instrumental broadening and continued from that assumption.

(C-4)T

Blokhin, M. A., INSTRUMENTAL DISTORTION OF X-RAY SPECTRA. Doklady Akad. Nauk S.S.S.R. 107, 229-232 (1956). Trans: Sov. Phys. "Doklady" 1, 165-168 (1956).

1. The case of nondispersive asymmetric distortions in a double crystal spectrometer was developed.
3. A "true line shape" was assumed and corrections were developed for a distorted line of any shape but not of any width.

(C-5)T

Eisenstein, J. C. USE OF f ORBITALS IN COVALENT BONDING. J. Chem. Phys. 25, 142-146 (1956).

1. The compounds  $(UO_2)^{++}$ ,  $UCl_6$ , and  $UCl_4$  were discussed and the use of f uranium orbitals for covalent bonding in these compounds was postulated.
3. Tables showing which atomic orbitals can be combined to form bonding orbitals for a number of different spatial arrangements of the bonds are presented.

(C-6)E

Harrower, G. A., ENERGY SPECTRA OF SECONDARY ELECTRONS FROM Mo AND W FOR LOW PRIMARY ENERGIES. Phys. Rev. 104, 52-56 (1956).

1. Energy spectra were measured using primary voltages of 0-100V.

2. An electrostatic analyzer was used at  $127^\circ$ ; specimens were at a vacuum of  $5 \times 10^{-10}$  mm Hg and were cleaned by flashing.
3. Monolayer adsorption time on the targets was inversely proportional to the pressure; it was 1 second at  $10^{-6}$  mm Hg.

(C-7)T

Karnatak, R. C. and Y. P. Varshni, SCREENING CONSTANTS IN X-RAY SPECTRA. (In English.) Z. Physik 145, 341-346 (1956).

1. The X-ray screening constant  $\sigma_2$  for  $L_2L_3$ ,  $M_2M_3$  and  $M_4M_5$  is calculated.
2. Sommerfeld theory was used.
3. Values of  $\sigma_2$  for elements of  $Z = 23-92$  are tabulated.

(C-8)E

Katamadze, V. R., REFRACTIVE INDEX OF X-RAYS IN METALS. (In Russian.) Trudy Stalinirsk. gosudarst. Inst. 3, 589-598 (1956). Annotated from Abs. J. Met. (U.S.S.R.) 1958 (3-4) 44 (Abs. 8106).

1. The energy of reflected X-rays from mirror surfaces of Al, Fe, Ni, and Cu was studied in the wavelength region 0.710 to 1.933A.
2. These energies were found from photographs taken at angles of incidence less than a factor of 1.3 of the critical angle.
3. The index of refraction is then found; the results agree within 2% of the theoretical values predicted by the Kalman-Mark formula.

(C-9)T

Richardson, J. W. and R. E. Rundle, THEORETICAL STUDY OF ELECTRONIC STRUCTURES OF TRANSITION METAL COMPLEXES. U.S. At. Energy Comm. ISC-830, 118 pp. (1956).

1. New findings on metal-ligand interactions and on extra valence shell orbitals for the ligand are listed.
- 2a. A semi-empirical theory based on Roothan's self-consistent field molecular orbital procedures and on Mulliken's approximations for certain molecular integrals was devised.
- 2b. Only valence shell atomic orbitals were used.
3. Tables of results are presented.
4. It is possible to use these methods in bonding problems in intermetallic compounds and other alloys.

(C-10)E

Takeishi, Y., AUGER EJECTION OF ELECTRONS FROM BaO BY INERT GAS ATOMS. J. Phys. Soc. Japan 11, 676-689 (1956).

1. Auger transitions are tabulated.
3. The total Auger yield was found to be about 0.475 for inert gas atoms of several energies.
- 4a. The energy gap is 0.8 - 1.0 eV in BaO.
- 4b. The top of the filled band is 5.1 eV or more

(C-10)E Cont'd.

below the vacuum level and the width is 6-9 eV.

(C-11)E

Tomboulia, D. H. and P. L. Hartman, SPECTRA AND ANGULAR DISTRIBUTION OF ULTRAVIOLET RADIATION FROM THE 300-MEV CORNELL SYNCHROTRON.

Phys. Rev. 102, 1423-1447 (1956).

- 1,2a. A grazing incidence grating spectrograph was used with photographic means in order to record the average power spectrum emitted over a partial or full synchrotron acceleration interval in which the electron energy was 233 or 321 MEV.
- 2b. The grating reflecting power was determined with monochromatic sources; this enabled the synchrotron continuum to be evaluated from 60-200A.
- 3a. Results are in good agreement with the theory of accelerated electrons.
- 3b. The Be-K and the Al-L<sub>2,3</sub> absorption edges were obtained by use of the synchrotron continuum as the radiation source. The Be-K edge is 111A and the Al-L<sub>2,3</sub> edge is 170A.

1957

(1)E

Agarwal, B. K. and M. P. Givens, SOFT X-RAY ABSORPTION BY THIN FILMS OF CHROMIUM.

Phys. Rev. 107, 62-64 (1957).

1. Absorption and emission spectra of Cr were studied in the spectral region of 250-300A.
3. The observed absorption band was interpreted as a combination of M<sub>3</sub> and M<sub>2</sub> bands in the ratio 3:2 and separated by 1.5 eV.
4. The absorption produced is from the transition 3P<sub>3/2-1/2</sub> to the unfilled portion of the conduction band.

(2)E

Agarwal, B. K. and M. P. Givens, SOFT X-RAY ABSORPTION BY THIN VANADIUM FILMS.

Phys. Rev. 108, 658-659 (1957).

1. The absorption of soft X-rays by V over a spectral region of 190-250A was measured.
2. Films 25-300A thick deposited at a pressure of 10<sup>-4</sup> mm Hg were employed.
3. Soft X-ray data for Fe, Cr, and V are compared; total (emission and absorption) width and absorption spectra for Fe and V are given.
4. The observed absorption band for V is interpreted as a combination of M<sub>3</sub> and M<sub>2</sub> bands in the ratio of 2:1 and separated by 1.5 eV.

(3)T

Barinskii, R. L., E. E. Vainshtein and K. E. Narbutt, DEPENDENCE OF X-RAY ATOMIC ABSORPTION SPECTRA IN COMPOUNDS ON THE CHARACTER OF THE CHEMICAL BOND. (In Russian.)

Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1351-1361 (1957).

Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1341-1350 (1957).

1. The K absorption edge fine structure of Zn,

K, and Cl in ionic compounds as a function of the nature of the chemical bond is discussed.

- 3a. Rules are established permitting the prediction of the position and relative intensity of the lines of one component in a compound provided these data are available for the other component.

- 3b. All spectra are presented.

(4)E

Barinskii, R. L., K ABSORPTION SPECTRA OF CHLORINE IN ALKALI METAL CHLORIDES. (In Russian.)

Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1381-1386 (1957).

Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1369-1374 (1957).

1. Sintered LiCl, NaCl, KCl, RbCl, and CsCl were studied.
2. A bent crystal (quartz) spectrograph was used and intensities were photographically recorded.
3. The line widths increased with the decrease of the ionic radius of the cation; the spectra are shown.
4. The effective quantum number of the series is directly proportional to the polarizability of the cation.

(5)E

Barinskii, R. L. and E. E. Vainshtein, X-RAY ABSORPTION AND EMISSION L SPECTRA OF Mo IN THE CARBIDE AND SOME OTHER COMPOUNDS. (In Russian.)

Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1387-1396 (1957).

Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1375-1384 (1957).

1. The L<sub>3</sub> absorption edge and the Lβ<sub>2</sub> emission line of Mo in MoC<sub>2</sub>, (NH<sub>4</sub>)<sub>2</sub> MoO<sub>4</sub>, MoO<sub>3</sub>, and MoS<sub>3</sub> and MoS<sub>2</sub> were investigated.
2. A bent crystal (quartz) spectrograph was used; Intensities were recorded photographically.
- 3a. A group of very intense selective lines were found 11-15 eV from the edge in all absorption spectra obtained.
- 3b. The results show that the 4d band is free in (NH<sub>4</sub>)<sub>2</sub> MoO<sub>4</sub>, that there is a d<sup>4</sup> sp hybridization in MoS<sub>2</sub> and a partial bond hybridization in MoC<sub>2</sub>.
- 3c. All spectra are presented.

(6)E

Baumann, E. and K. Ulmer, THE ABSORPTION OF SOFT X-RAYS IN THE NEIGHBORHOOD OF THE K EDGE IN Mg. (In German.)

Z. Naturforsch, 12a, 670-671 (1957).

1. The absorption was measured between 7 and 24A.
- 3a. The mass absorption coefficients are presented.
- 3b. The Bragg-Pierce law constant for this case is given.

(7)E

Bedo, D. E., THE K SPECTRUM OF LITHIUM.

Univ. Microfilms PUBL 21074, 93 pp. (1957).  
Diss. Abs. 17, 1097-1098.

1. The 60-600A region was investigated.
2. A grating spectrometer at grazing incidence, evacuated to 1 X 10<sup>-6</sup> mm Hg, was used to detect the astigmatically focused image by

(7)E Cont'd.

photographic means.

- 3a. The band does not show a high energy cut-off.
- 3b. A satellite band with a maximum at 82.83 eV was found.
4. The experimental intensity distribution as a function of the energy of photons is proportional to the product of the transition probability for allowed transitions and the level density functions for the specific excited solid.

(8)T

Blokhin, M. A. and V. P. Sachenko, WIDTHS OF INTERNAL LEVELS AND ENERGY-DENSITY DISTRIBUTIONS OF ELECTRON STATES OF THE IRON GROUP TRANSITION ELEMENTS. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1342-1350 (1957).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1333-1340 (1957).

- 1,2. The widths of K levels for  $Z = 12-79$  (35 elements shown) were calculated from transition probabilities and the fluorescence yield. Similar calculations were made of the  $L_{2,3}$  levels for  $Z = 22-47$  (19 elements shown).
- 3a. Calculated data agree with Beeman and Friedman for the density states for copper.
- 3b. Complete tables of the line widths obtained by the calculations are presented.
- 3c. "Corrected" spectra for Beeman and Friedman's data (Ref. #1, 1939) are shown.

(9)E

Boke, K., K ABSORPTION EDGE FINE STRUCTURE. (In German.)  
Z. Physik Chem., Frankfurt (NF) 10, 45-82 (1957).

1. The K absorption edge was studied in transition metal complexes, chiefly carbonyl and cyano complexes, both at liquid oxygen temperature and at 300°K.
2. A double crystal spectrometer was used.
- 3a. An extrapolation method allowing one to get the absorption curve for the pure element from material of lower purity is described.
- 3b. Results at liquid  $O_2$  temperature were the same as at 300°K.
4. For the absorption edge of the ions, the experimental values with respect to the position and distances of p levels conformed to theory.

(10)E

Boke, K., K EDGE FINE STRUCTURE OF TRANSITION ELEMENT COMPLEXES OF Cr AND Zn. (In German.)  
Z. Physik Chem. Frankfurt (NF) 11, 326-336 (1957).

1. The slope of absorption curves is discussed in connection with molecular level theory.
3. Empirical statements which can be deduced from the data are tabulated.

(11)E

Bonnelle, C. and C. Mande, THE L SPECTRUM OF PALLADIUM. (In French.)

Compt. Rend. (French Academy) 245, 2253-2256 (1957).

1. Weakly bound electrons and vacant states near the Fermi level were investigated by means of the  $L\beta_2$  spectrum of Pd.
2. A curved crystal spectrometer with a dispersive power of 5.4 eV/mm was used and intensities were photographically recorded.
- 3a. The emission band is unsymmetrical on the high energy side with secondary maxima due to satellites.
- 3b. The  $L_3$  absorption edge was found to be 1 eV above the emission maximum.

(12)E

Borisov, M. D., SELECTION OF THE OPTIMUM CONDITIONS FOR EXPOSURE AND PHOTOMETRY OF X-RAY BANDS. Voprosy Fiz. Metal. i Metalloved. Akad. Nauk Ukr. S.S.R. Sbornik Nauch. Rabot 1957 (8) 209-214. Annotation from Chem. Abs. 55, 7030c

1. The resolving power of a crystal spectrograph is discussed from the point of view of the effect of the slit width and the film grain size.

(13)E

Borisov, M. D., V. V. Nemoshkalenko and A. M. Fefer, X-RAY INVESTIGATION OF THE DISTRIBUTION OF ELECTRONS AMONG STATES IN METALS AND ALLOYS. (In Russian.)  
Izvest. Akad. Nauk. S.S.S.R. Ser. Fiz. 21, 1424-1434 (1957).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1412-1422 (1957).

1. The  $K\beta_5$  and  $K\beta_1$  lines of Cr-Fe alloys containing 4, 5.8, 8, 20, 30, 45, 50, and 75 w/o Cr were investigated at 1000°C.
2. A bent crystal (quartz) spectrograph was used; intensities were recorded photographically.
3. The Fe- $K\beta_1$  and  $K\beta_5$  and the Cr- $K\beta_1$  were not affected by concentration, but the Cr- $K\beta_5$  was displaced to longer wavelengths while the absorption edge was shifted to lower wavelengths with increasing iron concentration.
4. The conduction bandwidth reaches a maximum for intermediate concentrations of Fe and Cr.

(14)E

Borovikova, G. P., and M. I. Korsunskii, X-RAY SPECTRUM OF THE L SERIES OF Ge. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1438-1444 (1957).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1426-1431 (1957).

1. The L spectra of both Ge and  $GeO_2$  were studied.
2. A bent crystal (mica) spectrograph was used; intensities were recorded photographically.
- 3a. The  $L\alpha_x$  and  $L\beta_x$  disappeared in  $GeO_2$  owing to the loss of Ge electrons to oxygen.
- 3b. Actual spectra are presented.

(15)E

Borovskii, I. B. and G. N. Ronami, THE INFLUENCE OF THERMAL VIBRATIONS OF ATOMS ON THE ELECTRON ENERGY SPECTRUM OF METALS AND ALLOYS.



(15)E Cont'd.

(In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21,  
1397-1400 (1957).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser.  
21, 1385-1388 (1957).

1. The  $L_3$  absorption spectra of Pb with 0.2, 0.5, 2.0 and 10 w/o Sn, PbO, and PbO<sub>2</sub> were investigated at -190 to 300°C.
2. A bent crystal spectrograph was used, and intensities were photographically recorded.
- 3a. The fine structure in Pb and Pb-10% Sn disappears at 200°C, but it still persists at 300°C in Pb with 0.2-0.5% Sn.
- 3b. Fine structure data and the experimental spectra are tabulated.

(16)E

Cauchois, Y. and C. Bonnelle, NEW STUDY OF THE L SPECTRA OF NICKEL AND COPPER. (In French.)  
Compt. Rend. (French Academy) 245, 1230-1233 (1957).

1. Both the emission and absorption spectra of Ni and Cu were obtained.
2. A bent crystal (gypsum or mica) spectrograph was used and intensities were recorded photographically.
- 3a. Strong white rays were found in the absorption spectra of Ni (absent in Cu) and these rays were attributed to 'd' shell vacancies.
- 3b. Emission bandwidths of 2.2 eV for Ni and 3.8 eV for Cu (in agreement with Shaw) were found.

(17)E

Dilmore, B. L., G. L. Rogosa and G. Schwartz, THE Np L X-RAY ABSORPTION SPECTRUM.  
Bull. Am. Phys. Soc. (2) 1, 258 (1957).

2. A double crystal spectrometer was used to study an HNO<sub>3</sub> solution of Np<sup>237</sup> and intensities were recorded with a scintillation counter.
3. 

<u>L edge</u>	<u>Value (keV <math>\pm</math> 5eV)</u>
L <sub>1</sub>	22.432
L <sub>2</sub>	21.594
L <sub>3</sub>	17.610

(18)E

Doran, D. G. and S. T. Stephenson, THE K ABSORPTION EDGE IN A SINGLE CRYSTAL OF Ge.  
Phys. Rev. 105, 1156-1157 (1957).

1. The extended fine structure on the short wavelength side of the Ge-K edge was studied; measurements extended 300 eV from the edge.
2. A double crystal spectrometer was used to examine the 100 $\mu$  thick crystal.
3. The spectrum and tabular results are presented.

(19)E

Eberbeck, W., K EDGE STRUCTURES OF ELEMENTS IN A<sup>3</sup> B<sup>5</sup> COMPOUNDS. (In German.)  
Z. Physik 149, 412-424 (1957).

1. The K absorption spectra of GaP, GaAs, GaSb, InAs and ZnS were studied, and absorber thicknesses and absorption maxima and minima were tabulated.
3. The separation of the closest absorption maximum from the edge was:

GaSb	5.8 eV
GaAs	7.1 eV
GaP	8.6 eV
4. These separations correspond to decreasing electrical conductivity of the compounds as the conduction band is shifted to higher energies and becomes more nearly empty.

(20)E

Henke, B. L., R. White and B. Lundberg, MASS ABSORPTION COEFFICIENTS FOR 5-50A X-RAYS.  
J. Appl. Phys. 28, 98-105 (1957).

- 1,2. The mass absorption coefficients for Z = 1-36 were determined by a semi-empirical relationship.
- 3a. A universal function was set up and from it tables were computed for absorption by K shell electrons and also for absorption by L and extra L shell electrons.
- 3b. Tables of mass absorption coefficients are given for Z = 1-36 at 8.34, 13.3, 17.6, 21.7, 23.7, 27.4, 31.6, 36.3 and 44.0 A.

(21)A

Jaegle, P., DIFFRACTION OF SOFT X-RAYS PRODUCED BY TWO GRATINGS. (In French.)  
Compt. Rend. (French Academy) 245, 1412-1415 (1957).

- 1,2. Two consecutive concave gratings were used to disperse 20A X-rays.
- 3a. A series giving the amplitude of the diffraction spot in the final pattern was obtained.
- 3b. The diaphragm projecting the intermediate spot is capable of modifying the shape of the diffraction pattern.

(22)T

Karal'nik, S. M., EXTERIOR SCREENING AND THE FINE STRUCTURE OF X-RAY SPECTRA. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1445-1457 (1957).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1432-1439 (1957).

1. The effect of bonding in solid compounds on the screening of electrons appears as K absorption edge displacement.
2. The value of the screening of the 1s shell by a single outer electron was calculated from the displacement per unit valence of



(22)T Cont'd.

the K edge in inorganic compounds of V, Cr, Mn, Fe, Ni, and Na.

- 3a. The screening value was about 0.008 in the Fe group and 0.018 in sodium.
- 3b. In  $\text{Cr}_2\text{O}_3$ ,  $\text{MnO}$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{Ni}_2\text{O}_3$ , the K edge shifts to shorter wavelengths and the  $\text{K}\beta_5$  to longer wavelengths.
4. This shift is attributed to 4s and 3d electrons both being active in the chemical bond.

(23)E

Kazantsev, V. A., CHROMIUM K EDGE ABSORPTION IN  $\alpha$  AND  $\sigma$  PHASES OF THE Fe-Cr ALLOY SYSTEM. (In Russian.) Doklady Akad. Nauk S.S.S.R. 115, 501-503 (1957).

1. Data on the 3d and 4sp bands in the alloys in the  $\alpha$  and  $\sigma$  phases was obtained.
2. A curved crystal spectrometer was used and intensities were photographically recorded.
- 3a. On the formation of the  $\sigma$  phase, the K edge shifted towards lower energies - the inflection point of the 3d band by 3.2 eV and the midpoint of the 4sp band by 4.6 eV.
- 3b. 

Phase-band	Width	Phase-band	Width
$\alpha$	(eV)	$\sigma$	(eV)
3d	1.2	3d	7.0
4sp	17.0	4sp	13.0
- 3c. Actual spectra are presented.

(24)E

Korsunskii, M. I. and Ya. E. Genkin, NIOBIUM  $\text{L}\beta_2$  AND  $\text{L}\gamma_1$  EMISSION FIELDS IN NIOBIUM NITRIDE, NIOBIUM CARBIDE, AND NIOBIUM BORIDE. Trudy Seminara po Zharostoikim Materialam, Akad. Nauk Ukr. S.S.R. Inst. Metallokeram. i Spetsial. Splavov, Kiev. 1957 (5) 15-20. (Pub. 1960) Annotation from Chem. Abs. 55, 12025e.

1. The shapes and intensities of the L lines of  $\text{NbN}$ ,  $\text{NbC}$ , and  $\text{NbB}_2$  are compared to those of pure Nb.
2. Crystal spectrometry was used.
3. The compounds showed less intensity and different shapes than did the parent metal due to line splitting.
4. The alteration in shape was due to electronic transitions from the d level of Nb.

(25)E

Lucasson-Lemasson, A., L EMISSION SPECTRA OF COPPER IN ALLOYS. (In French.) Compt. Rend. (French Academy) 245, 1794-1797 (1957).

1. The  $\text{L}\alpha$  band of Cu alloyed with Ni, Zn, and Al was studied.
2. A bent crystal (gypsum) spectrograph having a dispersive power of 2.1 eV/mm was used and intensities were photographically recorded.
- 3a. A satellite  $\alpha'''$  was found in all alloys.
- 3b. Spectra and a table showing the characteristics of all alloys studied are presented.

(26)A

Lukirskii, A. P., A VACUUM X-RAY SPECTROGRAPH WITH GEIGER COUNTER FOR THE INVESTIGATION OF THE ENERGY LEVELS IN SOLIDS. (In Russian.) Radiotekh. i Elektron. 2, 328-333 (1957). Trans: Radio Engineering and Electronics (U.S.S.R.) 2 (3), 99-106 (1957).

1. A 600 lines/mm (15,000 lines/in) grating spectrograph was constructed for use in the 20-120A spectral region.
- 3a. A  $2.5^\circ$  grazing angle was employed.
- 3b. A Geiger counter was used to measure the intensities.
- 3c. The vacuum was  $10^{-5}$  mm Hg.
- 3d. The apparatus is described and illustrated.
- 3e. Calibration-type spectra of Be and Pb are shown.

(27)E

Mande, C., K ABSORPTION SPECTRA OF PALLADIUM AND PALLADIUM-GOLD ALLOYS. (In French.) Compt. Rend. (French Academy) 244, 747-749 (1957).

1. The second order spectra of Pd pure and in Pd-67 w/o Au and Pd-45 w/o Au were studied.
2. A curved crystal spectrometer was used and intensities were photographically recorded. Resolution was better in the pure metal than in the alloy.
- 3a. The edge discontinuity was resolved into two branches,  $\text{K}_1$  and  $\text{K}_2$ .
- 3b.  $\text{K}_1/\text{K}_2$  increased with Pd additions in the alloys.
- 3c. The K edge width was found to be 7.5 eV.

(28)A

Mitra, B. and K. Das Gupta, NEW BENT CRYSTAL SOFT X-RAY SPECTROGRAPH. J. Sci. Indust. Research (India) 16B, 524-527 (1957).

1. A curved mica crystal spectrometer is described.
- 3a. The crystal and cassette were fixed; the target was movable.
- 3b. The vacuum was  $5 \times 10^{-6}$  mm Hg.
- 3c. Photographic photometry was used to determine intensities.
- 3d. A dispersion of 16 XU/mm for 8th order  $\text{Cu-K}\alpha_1$ ,  $\alpha_2$  can be obtained.

(29)E

Moore, H. R., L SERIES EMISSION SPECTRUM OF KRYPTON. Proc. Phys. Soc. (London) 70A, 466-473 (1957).

1. Tabular data and spectra for Kr are presented.
2. An electrodeless discharge source was used and spectra were photographically recorded with the aid of a bent crystal spectrometer.
- 3a. One quadrupole line, seven diagram lines, and ten satellites were obtained.
- 3b. The X-ray energy levels found were:

Level	Energy (eV)
$\text{L}_1$	1920
$\text{M}_{4,5}$	87
$\text{N}_1$	20

(30)T

Nigam, A. N., X-RAY SPECTRA OF POTASSIUM HALIDE CRYSTALS AND COLOR CENTERS IN THEM. Z. Physik 147, 264-270 (1957).

- 1,4. Possible correlations of the energy levels arising from color centers with the fine structure of X-ray absorptions of the potassium ion are postulated.

(31)T

Nikiforov, I. Ya., CALCULATION OF THE ENERGY DISTRIBUTION DENSITY OF ELECTRONIC STATES FROM X-RAY SPECTRA. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1362-1366 (1957). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1351-1355 (1957).

- 1,3a. A new method is proposed in order to approximate the experimental spectrum mathematically.
- 3b. The results are tabulated and a test spectrum obtained by applying the method is shown.

(32)T

Orlov, A. N. and A. V. Sokolov, STRUCTURE OF X-RAY EMISSION SPECTRA OF ORDERED ALLOYS. (In Russian.) Fiz. Metal. i Metallovedne 5, 390-394 (1957). Trans: Phys. of Metals and Metallography 5 (3) 7-11 (1957).

1. The intensity of X-rays emitted when electrons transfer from the conduction band to the L-level was calculated.
2. The one-electron theory of ordered solution forming BCC alloys was used.
3. Values for limits of conduction band and Fermi surface in eV were derived.

(33)E

Parratt, L. G., C. F. Hempstead and E. L. Jossem, THICKNESS EFFECT IN ABSORPTION SPECTRA NEAR THE ABSORPTION EDGE. Phys. Rev. 105, 1228-1232 (1957).

- 1,2. The role of the spectral window as it affects the details of the observed absorption spectrum (which the authors show, depends upon absorber thickness) is discussed for the 2-crystal spectrometer.
- 3a. The window effect may be serious when the window tails are extensive.
- 3b. Measurement of widths and of relative intensities are most sensitively involved, but wavelengths are also slightly affected.
- 3c. An optimum thickness equation is derived:

$$x_d = \frac{\ln(\mu_1/\mu_2)}{\mu_1 - \mu_2}$$

and values of  $x_d$  are tabulated.

- 3d. Spectra are presented, the thickness effect explained and the spectral window shape discussed and evaluated.
4. The details of the absorption spectrum depend upon the absorber thickness.

(34)E

Parratt, L. G. and E. L. Jossem, WIDTH OF THE VALENCE BAND IN KCl. J. Chem. Phys. Solids 2, 67-71 (1957).

1. Values for the effective dielectric constant and for the effective mass of the K-ls first excited state in KCl are obtained.
2. Crystal spectroscopy was used.
3. The chlorine-3p valence band is about 2 eV wide.
4. The base width of the valence band may be of the order of 1 eV and the half maximum width of the density of states curve for this band may be about 0.3 eV.

(35)E

Rumyantsev, I. A. and M. I. Korsunskii, LINES  $L\beta_6$  AND  $Ly_5$  IN COPPER AND ZINC SPECTRA. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1435-1437 (1957). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1423-1425 (1957).

- 1,2. A bent crystal (mica) spectrograph was used to study Cu, Zn, and their oxides and the spectra were photographically recorded.
- 3a. Oxidation increased the intensity of the lines due to the 4s transition to the oxygen atom.
- 3b. The actual experimental spectra are presented.

(36)E

Smirnova, I. S. and K. I. Narbutt, INVESTIGATION OF THE FINE STRUCTURE OF X-RAY ABSORPTION SPECTRA IN ALKALI HALIDES. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 21, 1375-1380 (1957). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 21, 1363-1368 (1957).

1. The fine structure of the  $L_3$  absorption of iodine in LiI, NaI, KI, RbI, CsI and of Cs in CsF, CsCl, CsBr, and CsI was studied.
2. A curved crystal (quartz) spectrometer was used and the spectra were photographically recorded.
- 3a. The  $L_3$  spectrum is a superposition of two series - the s and d.
- 3b. For the d series of Cs, the principal quantum numbers are 1.41 and 1.55 based on the results for CsI.
- 3c. All spectra and a graphical analysis of them are presented.

- (37)E  
Tombouliau, D. H., D. E. Bedo and W. M. Neupert,  
**M<sub>2,3</sub> ABSORPTION SPECTRA OF THE ELEMENTAL  
SOLIDS Cr THROUGH Ge.**  
J. Chem. Phys. Solids 3, 282-302 (1957).
1. The elements Cr through Ge were studied in the 80-300A region; thin evaporated films were used as absorbers.
  - 2a. A grazing incidence grating spectrograph was used and intensities were recorded photographically.
  - 2b. The radiation source was produced by a condensed discharge in a pyrex capillary.
  3. All spectra and tabulated results including secondary structure and characteristic electron energy losses are presented.
- (38)T  
Trapeznikov, V. A., **THEORY OF FINE STRUCTURE OF  
X-RAY ABSORPTION SPECTRA OF SOLIDS.**  
Fiz. Metal. i Metallovedne 5, 8-14 (1957).  
Trans: Phys. of Metals and Metallography 5, (1) 5-12 (1957).
1. Temperature and concentration dependence of fluctuations in the fine structure are discussed.
  2. Kostarev's theory was used.
  4. Bonding forces can be studied by means of X-ray absorption spectra.
- (39)E  
Tsutsumi, K., A. Hayase and M. Sawada, **FINE STRUCTURE OF X-RAY Cu-K ABSORPTION SPECTRA OF Cu IN COMPOUNDS.**  
J. Phys. Soc. Japan 12, 793-801 (1957).
1. Some 12 organo-metallics and inorganic Cu compounds were studied.
  2. A standard Norelco diffractometer was used.
  3. Actual spectra and tabular results are presented.
  4. The observed fine structure is due to the immediate surroundings of the atom.
- (40)E  
Vainshteln, E. E. and Iu. N. Vasil'ev, **THE INFLUENCE OF CHEMICAL BONDS ON THE FINE STRUCTURE OF TITANIUM K LINES IN COMPOUNDS. (In Russian.)**  
Doklady Akad. Nauk S.S.S.R. 114, 53-56 (1957).  
Trans: Sov. Phys. "Doklady" 2, 207-209 (1957).
1. TiC and TiWC<sub>2</sub>, TiN, TiH, and TiO<sub>2</sub> K $\beta$  groups were studied with special emphasis on the K $\beta$ <sub>5</sub>.
  2. A curved crystal spectrograph (quartz) was used and intensities were photographically recorded.
  3. All spectra are shown but no bonding scheme is postulated.
- (41)E  
Vainshtein, E. E. and Iu. N. Vasil'ev, **THE TITANIUM K GROUP IN TITANIUM CARBIDE. (In Russian.)**  
Doklady Akad. Nauk S.S.S.R. 114, 1-3 (1957).  
Trans: Sov. Phys. "Doklady" 2, 251-254 (1957).
1. Carbides with carbon content varying from 9-24% were studied.
2. A bent crystal (quartz) spectrograph with a dispersive power of 5.7 XU/mm was used; the observed second order intensities were recorded photographically.
  - 3a. All spectra are presented.
  - 3b. The separation of the K $\beta$  and K $\beta$ <sub>5</sub> peaks was 7.9 eV in carbides of different compositions.
- Vasil'ev, Iu. N., - See E. E. Vainshtein.  
White, R., - See B. L. Henke.
- (42)E  
Zwerdling, S. and R. S. Halford, **K ABSORPTION EDGES IN COMPLEXES OF Cr, Mn, Fe AND Co.**  
J. Chem. Phys. 26, 1758-1759 (1957).
1. Spectra for 10 complexes are given.
  3. 1s  $\rightarrow$  4p can occur with and without change of the 3d configuration from <sup>3</sup>F to <sup>3</sup>P.
- (C-1)T  
Adams, E. N., **DEFINITION OF ENERGY BANDS IN THE PRESENCE OF AN EXTERNAL FORCE FIELD.**  
Phys. Rev. 107, 698 (1957).
- 1,3. An electron moving in a periodic potential perturbed by a weak electric field has different physical energy bands than it has when it moves in the absence of a field.
- (C-2)T  
Altmann, S. L., C. A. Coulson and W. Hume-Rothery, **ON THE RELATION BETWEEN BOND HYBRIDS AND THE METALLIC STRUCTURES.**  
Proc. Roy. Soc. (London) A-240, 145-160 (1957).
1. A qualitative means of determining the bonding in FCC, HCP, and BCC type structures is presented.
  - 3a. The metallic bond has certain directionality; this directionality is related to symmetries of known hybrid bonds.
  - 3b. Hybrids of gerade and ungerade orbitals (sp<sup>3</sup>) bias the electron cloud to one side of the atom giving rise to directional strong bonding; gerade orbitals double the possible number of ligands.
- (C-3)T  
Borovskii, I. B., and K. P. Gurov, **THEORY OF SOLID SOLUTIONS. (In Russian.)**  
Fiz. Metal. i Metallovedne 4, 187 (1957).  
Trans: Phys. of Metals and Metallography 4, (1) 154-5 (1957).
- 1,4. Electron energy spectra of solid solutions are discussed from the viewpoint that impurities and temperature must be carefully controlled in order to get reproducible X-ray results.
- (C-4)T  
Brout, K., **WIDTH AND SHIFT OF SPECTRAL LINES DUE TO DISSIPATIVE INTERACTION.**  
Phys. Rev. 107, 664-668 (1957).



(C-4)T Cont'd.

- 1,3. The width of a spectral line is the difference in widths of the two microscopic states before and after the transition. The natural line width is the sum of the two states involved.

(C-5)T

Callaway, J. and E. L. Haase, ELECTRON ENERGY BANDS IN Cs.  
Phys. Rev. 108, 217-221 (1957).

1. Energy levels are calculated and an estimate is made of the magnitude, at a nucleus, of the wave function of an electron on the Fermi surface.
- 2a. Orthogonal plane wave and cellular methods were applied to calculate the energy levels.
- 2b. The same crystal potential was used for all states and the wave functions of the core electrons for this potential were found.
3. Energies of 24 states at four Brillouin zone symmetry points are calculated.

(C-6)E

Fairbrother, J. A. V., D. G. Parkyn and B. M. O'Connor, THE K-AUGER YIELD FOR TIN.  
Proc. Phys. Soc. (London) 70A, 262-274 (1957).

1. The fluorescent yield  $\omega_K$  is determined for Sn.
3. Burhop's probability values give  $0.164 \pm 8\%$  as the K-Auger yield or  $0.836 \pm 1.5\%$  as  $\omega_K$ .
4. One can compute Auger transition probability.

(C-7)T

Greiner, H., and E. Schaffer, SAYA'S THEORY OF THE CONCAVE GRATING SPECTROMETER. (In German.)  
Optik 14, 263-276 (1957).

1. Concave grating spectrometers giving single reflections were investigated.
2. The Saya theory, providing a basis for a spectrometer design embodying fixed slits and a rotatable grating in order to vary the wavelengths is extended.
- 3a. An equation for the best angle between incident and reflected beams at small angles of grating rotation is derived.
- 3b. Focal curve plots for the angular defocusing vs. grating rotation are presented.

(C-8)E

Hanson, H. P. and J. Herrera, SELF-ABSORPTION IN THE X-RAY SPECTROSCOPY OF VALENCE ELECTRONS.  
Phys. Rev. 105, 1483-1485 (1957).

1. Target self-absorption modified  $K\beta_5$  emission profiles in W, Cu, and Fe are presented.
2. Commercial Norelco equipment was used.
- 3a. Actual spectra are shown.

- 3b. The effect produces an exaggerated asymmetry, depresses certain satellites, and produces an apparent coincidence of the absorption and emission edges.

(C-9)T

Lehman, G. W., ELECTRONIC PROPERTIES OF Th, U, AND Pu-ENERGY BAND STRUCTURE OF METALLIC PHASES.  
U.S. At. Energy Comm. NAASR-1839, 50 pp.(1957).

1. Band data calculations are presented for Th, U, and Pu; numerical data are given for the three lowest bands in Th.
- 2a. A simplified Slater-Koster interpolation method based on a cellular model was used.
- 2b. The energy matrix of the 6d band in Th was constructed from Bloch sums and the energy levels were found to be doubly degenerate at every point in the zone.
- 3a. Spin-orbit interaction modifies energy levels at points of Brillouin zone symmetry.
- 3b. The 6d bandwidth of Th is about 3.4 eV.
4. The valence electrons of Th occupy the 6d band while those of U and Pu occupy the 5f and 6d bands.

(C-10)T

Lomer, W. M. and W. Marshall, ELECTRONIC STRUCTURE OF METALS IN THE FIRST TRANSITION PERIOD.  
Phil. Mag. (8) 2, 185-203 (1957).

1. It is postulated that the electron distribution around atoms in a metal is greatly different from that in a free atom.
2. Using X-ray results, neutron diffraction data and magnetic measurements, an electronic structure is inductively reasoned.
3. Density of states data are proposed but no curves are given.
- 4a. Elements of atomic number less than Fe have few 3d electrons and many conduction electrons; while for those above Fe, this situation is reversed. This seems to be the case no matter what the crystal structure or alloy composition may be.
- 4b. The variation of saturation magnetic moment of all the binary ferromagnetic alloys can be explained on this basis.

(C-11)E

Patronis, E. T., C. H. Braden and L. D. Wyly, FLUORESCENCE YIELDS OF Ni, Cu, Zn, AND Pb.  
Phys. Rev. 105, 681-682 (1957).

- 1,2. The source was a radioactive excitant; detector was a proportional counter.

3. Element	Shell	Yield $\pm 0.02$
Ni	K	0.33
Cu	K	0.39
Zn	K	0.44
Pb	L	0.39



(C-12)E

Sokolowski, E., C. Nordling, and K. Siegbahn,  
MAGNETIC ANALYSIS OF X-RAY PRODUCED AUGER  
ELECTRONS.

Arkiv Fysik 12, 301-318 (1957).

1. Photo-electrons expelled from thin evaporated layers of Cu were studied by X-irradiation.
2. These were magnetically analyzed.
- 3a. Seven KLL-KLM Auger lines were resolved.
- 3b. Peaks due to electrons having suffered discrete energy losses were observed on the low energy flanks of the photo lines.
- 3c. Auger spectra and transition configurations are presented.
- 3d. K and L binding energies in Cu are 8985.5 eV and 1/100 eV respectively.

(C-13)E

Zinke, O. H., AUGER ELECTRONS IN MAGNESIUM.  
Phys. Rev. 106, 1163-1164 (1957).

- 1,3. Auger transitions in Mg are tabulated.
2. Mg was continuously evaporated onto the target surface at  $3 \times 10^{-6}$  mm Hg pressure in an X-ray tube equipped with a stainless steel anode and a gun to excite the Mg with 3-5 kV electrons at 5-20 ma: the Mg temperature was 345°C.

(C-14)E

Zinke, O. H., AUGER EFFECTS IN METALS.  
Univ. Microfilms PUBL 19976, 137 pp. (1957).  
Diss. abs. 17, 657.

1. Secondary electron spectra were studied.
2. These spectra were induced by primary electron bombardment.
3. The effects of varying surface treatments on these spectra are discussed.

1958

(1)E

Agarwal, B. K. and M. P. Givens, SOFT X-RAY ABSORPTION BY Mn AND MnO<sub>2</sub>.  
J. Chem. Phys. Solids 6, 178-179 (1958).

1. Mn and MnO<sub>2</sub> were studied between 45 and 60 eV.
2. Thin evaporated films 35-85 Å thick were used as absorbers.
- 3a. Mn and MnO<sub>2</sub> both showed an absorption edge near 50 eV.
- 3b. On the low energy side of the edge, MnO<sub>2</sub> has a larger absorption coefficient than Mn; it is also noted that this effect is present for Fe<sub>2</sub>O<sub>3</sub> over Fe.
- 3c. Actual absorption spectra are shown and results are compared to those of Tomboularian.

(2)E

Beckman, O., THE K X-RAY SPECTRUM OF MERCURY.  
Phys. Rev. 109, 1590 (1958).

- 1,3. K spectral observations in Hg are tabulated.
- 2a. A 2.5 meter radius bent crystal (quartz) spectrograph which focused rays on a slit 0.1 mm in front of an NaI scintillation

counter was employed.

- 2b. A Van de Graeff machine was used as a source of 600 kV on the X-ray tube.
- 2c. Measurements were taken for twelve hours after depositing Hg on a silver-amalgam anticathode.

(3)E

Borisov, M. D., V. V. Nemoshkaleiko and A. M. Fefer,  
ELECTRONIC BAND STRUCTURE OF Fe-Cr ALLOYS.  
(In Russian.)  
Doklady Akad. Nauk S.S.S.R. 121, 264-267 (1958)  
Trans: Sov. Phys. "Doklady" 3, 826-829 (1958).

1. Pure Fe, Cr, and 35, 45, and 55 w/o Cr alloys homogenized at 1150°C for 50 hours were studied; specimens were tablets sealed to the X-ray tube anode.
2. A bent crystal spectrograph was used in order to photograph  $\alpha$  and  $\sigma$  phase lines of the K $\beta$  group in the third and fourth orders.
- 3a. Spectra, tables, and a diagram of overlapping Cr and Fe energy bands in Fe-Cr alloys are presented.
- 3b. The energy band characteristics in the 600-1200°C temperature range are given.
- 3c. The Fermi energy in  $\alpha$  Fe-Cr is  $0.183 \pm 0.003$  V/R and it is not concentration dependent.
4. The shape of the K $\beta_5$  band of a metal is determined by the distribution function of the states occupied by electrons in the conduction band.

(4)E

Brummer, O., KIKUCHI BANDS FROM SOFT X-RAYS AND INFLUENCE OF CRYSTAL IMPERFECTION ON SUCH X-RAY INTERFERENCES. (In German.)  
Z. Naturforsch. 13a, 571-572 (1958).

1. Kikuchi patterns of etched Fe and Al single crystal spheres were produced.
2. A microfocus X-ray tube with Mo or Pt anodes was used; lines were recorded on photographic plates held 0.8 to 40 mm from the anode.
3. Band intensities decrease with increasing crystal perfection.
4. Kikuchi bands are limited by short wave interference from continuous radiation.

(5)A

Catterall, J. A., L. F. Wilson and J. Trotter,  
SOFT X-RAY SPECTROSCOPY USING AN ELECTRON MULTIPLIER.  
J. Sci. Instr. 35, 393-395 (1958).

1. A Be-Cu electron multiplier which was insensitive to radiation above 3000 Å was used to record intensities in a grating spectrometer.
- 2a. Spectra were excited with 500-1000 volt electrons with 5-10 ma emission current at a pressure of  $6-7 \times 10^{-6}$  mm Hg.
- 3a. The slit width of the photomultiplier was chosen as 0.1 mm.
- 3b. A glass window was inserted in the spectrometer wall in order to observe the Rowland circle during the experiment.

(6)E

Cotton, F. A. and H. P. Hanson, SOFT X-RAY ABSORPTION EDGES OF METAL IONS IN COMPLEXES. III. ZINC (II) COMPLEXES. J. Chem. Phys. 28 (1), 83-87 (1958).

1. The K X-ray absorption edges of the  $Zn^{+2}$  ion in various complexes were measured.
2. A calcite double crystal X-ray spectrometer was used.
3. The significance of the fine structure of the K absorption edges with regard to the stereochemistry and electronic structure of the complexes is discussed.

(7)E

Crisp, R. S., SOFT X-RAY  $L_{2,3}$  EMISSION SPECTRA OF Mg FROM SOLID AND EVAPORATED TARGETS. Australian J. Phys. 11, 449-452 (1958).

1. The  $Mg-L_{2,3}$  was studied at 250A.
2. A one meter grazing incidence grating spectrograph equipped with a scraper to clean the solid metal surface was used; the electron gun was operated at 4 kV with a target current of 4 ma. A maximum counting rate of 4000 counts/sec. was obtained.
- 3a. After 35-40 minutes of bombardment a brownish film was visible on the target due to the deposition of carbon from residual organic vapors.
- 3b. A spectrum is shown but no calculated density of states curve is presented.
- 3c. A constant spectral window was obtained.

(8)E

Deodhar, G. B. and A. N. Nigam, X-RAY  $L_3$  ABSORPTION EDGES OF Pt AND Au IN COMPLEXES. (In English.) Naturwissenschaften 45, 309 (1958).

1. The wavelength of  $L_3$  edge in Pt and Au is tabulated for the materials studied.
- 3a. The effect of substitution is to shift the  $L_3$  edge toward lower frequencies.
- 3b. The shift was greatest for  $NaAuCl_4$ ,  $KAuCl_4$ ,  $K_2Pt(CN)_6$  and  $K_2PtCl_3$ .

(9)E

El-Hussaini, J. M. and S. T. Stephenson, SINGLE-CRYSTAL ORIENTATION EFFECTS IN K X-RAY ABSORPTION SPECTRA OF Ge. Phys. Rev. 109, 51-59 (1958).

- 1a. The extended fine structure on the short wavelength side of the edge was studied for three different orientations of the crystal.
- 1b. A single crystal of 7% Si in Ge was also investigated. Data were taken to 60 eV from the Ge-K edge and many changes noted.
2. For the Ge crystal, shifts in position of structure were observed between 75 and 280 eV from the edge; the polarization was only 7%.
3. Observed shifts are tabulated.

(10)E

Fisher, P., R. S. Crisp and S. E. Williams, A PHOTON COUNTING SPECTROMETER FOR THE 50-1000A RANGE. Optica Acta (Paris) 5, 31-39 (1958).

1. The apparatus is described in detail and preliminary spectra for Mg, Al, Na, Be, Cu, K, and Li, are shown.
- 2a. The instrument employs 1 m gratings of 570 or 1150 lines/mm (15,000 and 30,000 lines/in. respectively) at a  $5^\circ$  grazing angle; a Cu-Be photomultiplier with a potentiometer recorder is used for intensity determinations.
- 2b. Four kv electrons are used to excite the specimen; the specimen is scraped in vacuo to clean the surface.
- 3a. Curves of intensity vs. time are presented for various targets; contamination by oxygen and carbon is considered.
- 3b. Skinner's shape of the  $Cu-M_{2,3}$  band was obtained.

(11)A

Hanson, H. P. and R. Economy, CONTINUOUSLY ALIGNED GEARING SYSTEM FOR A SPECTROMETER. Rev. Sci. Instr. 29, 421-424 (1958).

1. A gearing system for a double crystal spectrometer which scans Bragg angles of  $10-45^\circ$  continuously is described.
2. Appropriate angular changes of the components are effected through a planetary gear system.
3. Design and description are detailed.

(12)E

Hayashi, T., T. Nishimura and M. Suzuki, TEST FOR THE RESOLVING POWER OF A CURVED CRYSTAL SPECTROGRAPH. Sci. Repts. Tohoku Univ. 41, First Ser. 183-187 (1958).

1. The image of a W wire was used to experimentally measure the resolving power of a quartz crystal spectrometer set in the Johann mounting.
- 2a. A 25 micron diameter W wire was placed such that its spectral image was formed at the central portion of the  $K\alpha_1$  line of Cu.
- 2b. Spectral images were obtained by photographic means; the spectrograms were analyzed microphotometrically.
- 3a. The half-width  $\Delta\lambda$  of the W image is found to be  $1/40.6$  of the interval between the  $K\alpha_1$  and  $K\alpha_2$  of Cu, i.e.,  $\Delta\lambda = 0.095$  XU.
- 3b. For the  $Cu-K\alpha_1$   $\lambda/\Delta\lambda = 1537/0.095 = 1.62 \times 10^4$  for the spectrometer investigated.

(13)E

Jacobs, E. S., X-RAY PHOTOELECTRIC SPECTRA FROM THIN METAL FILMS. Univ. Microfilms, PUBL MIC-58-3076, 105 pp. (1958). Diss. Abs. 19, 547.

(13)E Cont'd.

1. The photoelectron spectra of Ni, Cu, Rh, Pt, and Au were measured and values for each peak tabulated.
2. Monochromatic X-rays were used to excite the target; this permitted only photoelectrons from the innermost shells of the surface atoms to escape.
3. A general relationship to predict relative efficiency of varying the wavelength of monochromatic X-radiation for the generation of photoelectrons from the surface of any material is given.

(14)E

Korsunskii, M. I. and I. A. Rumyantsev, LINES  $L_6$  AND  $L_5$  IN X-RAY SPECTRA OF COPPER AND ZINC. (In Russian.) Issledovaniya. po Zharoproch. Splavam, Akad. Nauk S.S.S.R., Inst. Met. im. A. A. Baikova 3, 249-251 (1958). Annotation from Chem. Abs. 55, 1176 g.

1. Pure Cu and Zn were studied in order to establish the lines related to the transition of valence electrons.
- 3a. The short wave components of  $L\alpha_{1,2}$  and  $L\beta_1$  doublets are 65 XU from the basic line.
- 3b. These components are  $L\beta_6$  and  $L\gamma_5$  lines with transitions  $L_3 \rightarrow N_1$  and  $L_2 \rightarrow N_1$  respectively.
- 3c. The wavelength difference between  $L\alpha_2$  and  $L\beta_6$  and also between  $L\gamma_5$  and  $L\beta_1$  is 4.6 eV in Cu and 5.6 eV in Zn.

(15)E

Kotlyar, B. I. and G. A. Shapiro, INVESTIGATION OF THE  $K\beta$  GROUP OF THE X-RAY EMISSION SPECTRUM OF Mn AND Cu IN SOME ALLOYS OF THE Cu-Mn AND Cu-Mn-Al SYSTEMS. Nauch. Zap. Fiz. - mat. fak. Odessk. gos. ped. inst. 22, (1) 71-76 (1958). Ref: Abstracts Journal of Metallurgy Part A, No. 1-2, 1961 Abstract #46 (annotated from Abstract).

1. Binary Cu alloys containing 9.6 to 33.5 at.% Mn, and ternary alloys containing (in at.%) 22.7, 24.6 Mn and 8.2, 24.6 Al, respectively, were investigated. The latter alloy corresponds to  $Cu_2MnAl$  and is very ferromagnetic.
2. A Johann vacuum spectrograph was used, in a first order of reflection from the (1340) plane of quartz by primary method.
- 3a. The  $MnK\beta_1$  wavelength in  $Cu_2MnAl$  is displaced 0.61 eV towards long wavelengths.
- 3b. The max displacement of  $K\beta_1$  of Cu towards long wavelengths is observed for an alloy with 8.2 at.% Al. In this alloy the max displacement of  $K\beta_5$  of Mn is towards short wavelengths.
- 3c. For an alloy with 23.9 at.% Mn, the  $K\beta_5$  of Cu is displaced 0.94 eV towards long wavelengths. Al (8.2 at.%) added to a binary alloy displaces this line towards short wavelengths by 1.67 eV compared with pure Cu. In  $Cu_2MnAl$  alloy this displacement towards short wavelengths is equal to 0.94 eV.
- 3d. For  $Cu_2MnAl$  alloy, the wavelength of the  $MnK\beta_1$  max is displaced 1.89 eV towards long wave-

lengths when passing through the Curie point.

(16)E

Kotlyar, B. I., X-RAY SPECTROSCOPIC INVESTIGATION OF MAGNETIC TRANSFORMATIONS IN HEUSLER ALLOYS. (In Russian.) Nauch. Zapiski Kafedr. Mat. Fiz. i Estestvoznaniye Odess. Gosudarst. Pedagog. Inst. 22 (2) 60-61 (1958). Annotation from Referat. Zhur. Met. 1960 Abs. #3625.

1. The  $K\beta_5$  line of Mn and Cu in  $Cu_2MnAl$  in the transition from ferromagnetic to paramagnetic states was investigated.
3. The short wave edge of the  $K\beta_5$  shifted to higher energies in Mn and vice versa in Cu on transition to ferromagnetism.
4. This may be due to the transfer of some d electrons from Cu to Mn.

(17)E

Lucasson-Lemasson, A., K AND L ABSORPTION SPECTRA OF COPPER IN VARIOUS ALLOYS. (In French.) Compt. Rend. (French Academy) 246, 94-97 (1958).

1. The  $L_3$  absorption spectrum of Cu alloyed with Ni, Zn and Al, and the K absorption spectrum of Cu alloyed with Ni and Zn, pure Cu and CuO were studied.
2. A bent crystal (mica) spectrograph with a dispersive power of 83.5 eV/mm was used; intensities were recorded photographically.
3. No spectra are shown but all results giving the position and observed characteristics of the features studied are tabulated.

(18)E

Merrill, J. J. and J. W. M. DuMond. THE L X-RAY SPECTRA OF URANIUM AND PLUTONIUM. Phys. Rev. 110, 79-84 (1958).

- 1,3a. L spectral data for U and Pu are tabulated and compared with earlier work.
- 2a. A double crystal spectrometer was used.
- 2b. Target temperature was maintained at a constant value.
- 2c. All observed line breadths were corrected.
- 3b. A definition of the "X-unit" is given in an appendix.

(19)E

Nemmonov, S. A. and V. V. Kliushin,  $L_3$  ABSORPTION SPECTRA OF CERIUM IN Ce-Al ALLOYS. (In Russian.) Fiz. Metal. i Metallovedne 6, 951-952 (1958). Trans: Physics of Metals and Metallography 6, 183-185 (1958).

1. The  $L_3$  absorption edge in pure Ce,  $CeAl_2$  and  $CeAl_4$  was studied.
2. An logani bent crystal (quartz-38 cm radius) spectrograph with a linear dispersion of 2.48 XU/mm was used.
- 3a. Spectra for Ce and  $CeAl_2$  are shown.
- 3b. The  $2p \rightarrow 5d$  absorption line is displaced 1.6 eV in  $CeAl_2$ .



(19)E Cont'd.

4. The main Ce contribution to the bonding is due to 6s and 5d electrons.

(20)E

Nemnonov, S. A. and A. Z. Men'shikov, THE K ABSORPTION SPECTRUM OF CHROMIUM IN BORIDES, CARBIDES, NITRIDES, AND OTHER COMPOUNDS. Trudy Seminara po Zharostoikim Materialam Akad. Nauk Ukr. S.S.R., Inst. Metallokeram. i Spetsial, Splavov, Kiev. 1958 (5), 21-27 (Pub. 1960). Annotation from Chem. Abs. 55, 12025b.

1. The K edge in pure Cr,  $\text{Cr}_2(\text{SO}_4)_3$ ,  $\text{CrCl}_3$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{CrN}$ ,  $\text{CrB}_2$ ,  $\text{Cr}_3\text{C}_2$ ,  $\text{CrB}$ ,  $\text{Cr}_2\text{C}_3$ , and  $\text{Cr}_2\text{N}$  was studied.
3. Bonding between Cr and the hard metalloids changes from ionic-covalent to covalent-metallic.
4. It is not possible to refer metalloids to a metallic state.

(21)T

Parratt, L. G., NOTES ON THE PROSPECTIVE USE OF THE ORBIT RADIATION OF A HIGH ENERGY SYNCHROTRON IN X-RAY PHYSICS IN THE 0.1 TO 20A REGION. Office of Technical Services, PB135404, Tech. Note #1, 14 pp. (1958).

1. Results of the classical predictions of Schwinger concerning electromagnetic radiation from high energy electrons in circular orbits were put into practical form for 40-800A. (See Tomboulia, Phys. Rev. 102, 1423-1477 (1956)).
3. These results were extended to the 0.1-20A region and the total power radiated and the spectral distribution were calculated; beam geometry was discussed.

(22)E

Rudstrom, L. and S. Sjoberg,  $L_1$  X-RAY ABSORPTION SPECTRUM OF Se AND Se OXIDE. Arkiv Fysik 13, 297-302 (1958).

1. Metallic and vitreous Se and Se oxide were investigated at 7.5A.
2. A crystal spectrometer and photographic recording were used.
- 3a. Values for vitreous Se and Se oxide were in close agreement, but the Se metal edge was not.
- 3b. The energy shift between vitreous Se and Se oxide is 4.2 eV.
- 3c. Spectra and tabular data are presented.

(23)T

Sachenko, V. P., WIDTH OF INTERNAL LEVELS OF ATOMS. Uchenye Zapiski Rostov-Na-Donu Univ. 68 (8) 91-104 (1958). (In Russian.) Annotation from Chem. Abs. 55, 14049d.

- 1,3a. The widths of K levels for  $Z = 12-79$  and of the L levels for  $Z = 22-47$  were obtained by interpolating experimental data.
- 3b. The basis for these interpolations is presented.

(24)E

Sakellaridis, P., ADSORPTION STATES IN K ABSORPTION SPECTRA OF COBALT. (In French.) Compt. Rend. (French Academy) 247, 876-879 (1958).

1. The K absorption spectra of Co in  $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ ;  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ ;  $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ , and  $\text{Co}(\text{CH}_3\text{COO})_2$  pure and adsorbed on MgO are compared.
3. The discontinuity of K absorption of the Co adsorbed on MgO shifts toward shorter wave lengths.
4. Adsorption on MgO is a chemical reaction.

(25)E

Sakellaridis, P., CHARACTERISTIC MULTIPLETS IN THE X-RAY EMISSION SPECTRUM OF ERBIUM. (In French.) Compt. Rend. (French Academy) 247, 921-923 (1958).

1. The  $L\beta$  and  $L\gamma$  series in Er were studied.
2. A curved crystal spectrometer was used.
3. The frequencies and wavelengths for all maxima are tabulated; intensity curves for the transitions  $L_1-N_1$ ,  $L_1-N_4$ ,  $L_3-N_5$ , associated with the  $L\gamma_{10}$ ,  $L\gamma_9$ , and  $L\beta_{14}$  respectively, are given.
4. The results can be attributed to the existence of an incomplete 4f layer, i.e., the  $N_{6,8}$ .

(26)E

Sakellaridis, P., MICROPHOTOMETRIC MEASUREMENTS OF X-RAY ABSORPTION IN RARE EARTHS. (In French.) Chim. Chronika 23, (8-9), 231-235 (1958).

1. The  $L_1$ ,  $L_2$ , and  $L_3$  absorption spectra of Eu, Gd, Tb, Ho, Er, and Tm combined as the  $\text{M}_2\text{O}_3$  oxide were studied.
2. A curved crystal (mica) spectrograph was used; intensities were recorded photographically.
3. The exact wavelength values due to  $L_2$  and  $L_3$



(26)E Cont'd.

white ray satellites could not be located; no spectra are presented.

(27)E

Samylov, S. V., V. A. Tsukerman and I. S. Model, GLOW OF GASES IRRADIATED WITH SOFT X-RAYS. (In Russian.)

Zhur. Eksptl. i Teoret. Fiz. 34, 599-608 (1958)  
Trans: Sov. Phys. "JETP" 7, 414-420 (1958).

1. Plates of Be, Cu, Mo, Sn, and Pt were studied in a gas chamber containing air, A, or A-air, N or O mixtures.
2. An intensity of 600 r/sec was obtained with the tube at 50 kv, 40 ma, W anode, Be window, and gas chamber at 10 $\mu$  Hg pressure.
3. The gases glowed at the metal surface. A photograph of the airglow is shown.
4. The glow was attributed to electrons freed by X-rays which excited a thin gas layer at the metal surface.

Shapiro, G. A., - See B. I. Kotlyar.

(28)T

Shiraiwa, T., T. Ishimura and M. Sawada, THEORY OF FINE STRUCTURE OF X-RAY ABSORPTION SPECTRUM. J. Phys. Soc. Japan 13, 847-859 (1958).

1. The lifetime of the state of the electron ejected by absorption of a photon was considered.
2. Kronig's method for the molecule was used and applied to the solid; this gave reasonable transition probabilities.
3. Detailed calculations are given and results compared with tabulated experimental data.

(29)E

Sokolowski, E., C. Nordling and K. Siegbahn, CHEMICAL SHIFT IN INNER ELECTRON LEVELS OF Cu DUE TO OXIDATION. Phys. Rev. 110, 776 (1958).

1. A preliminary discussion of the data presented in Ref. #31 (1958) is given.

(30)E

Sokolowski, E., C. Nordling and K. Siegbahn, CHEMICAL SHIFTS IN INNER ELECTRON LEVELS IN A METAL RELATIVE TO ITS OXIDES. Arkiv Fysik 13, 483-500 (1958).

1. Thin (100A) evaporated layers of Cu, Cu<sub>2</sub>O and CuO were studied.
- 2a. A magnetic analysis of X-ray produced photoelectrons in these substances was performed.
- 2b. Electron diffractograms of the oxides were obtained in order to check their composition.
- 3a. Natural line widths changed with oxidation.
- 3b. A shift toward greater binding energies was observed in the order Cu, Cu<sub>2</sub>O, CuO; the shift is 4.4 eV for 1s and 2s in CuO.

- 3c. The CuO-KLL Auger line was much lower in energy than the Cu-KLL Auger line.
- 3d. Spectra and tabular data are presented, and transitions are discussed.
4. The K Auger yield may depend on the chemical composition of the source.

(31)E

Taft, E. A., PHOTOELECTRIC EMISSION FROM THE VALENCE BAND IN AgBr. Phys. Rev. 110, 876-878 (1958).

- 1,3. For photoelectric emission in AgBr, the threshold energy is about 6-7 eV and the band gap is 2.5 eV.
- 4a. The excited photoelectrons are scattered by the valence band electrons.
- 4b. The valence band lies 6 eV below vacuum energy.

(32)E

Tomboulion, D. H. and D. E. Bedo, THE K-EMISSION SPECTRUM OF METALLIC LITHIUM. Phys. Rev. 109, 35-40 (1958).

1. The K emission (2s  $\rightarrow$  K) spectrum of an evaporated Li target was investigated over a region of 60-600A.
- 2a. A grating spectrometer was used at 5.5° grazing angle and intensities were photographically recorded; the vacuum was 2 X 10<sup>-6</sup> mm Hg.
- 2b. Li was excited with 600 volts and 100 ma which raised the temperature to 26°C below the Li melting point.
3. The band has a maximum at 229.50A (54.02 eV), the distribution drops to half its maximum on the high energy side at 54.58 eV, and the decay intensity from the peak to the high-energy limit of the band occurs in an energy interval of 1.18 eV.

(33)E

Troneva, N. V., I. D. Marchukova and I. B. Borovski, L-SERIES OF CERIUM IN CeB<sub>6</sub> and CeO<sub>2</sub>. Fiz. Metal. i Metallovedne 6, 141-147 (1958). Trans: Physics of Metals and Metallography 6, 125-131 (1958).

1. L<sub>3</sub> absorption bands and L<sub>2</sub>β<sub>10</sub> emission lines were studied.
2. A bent crystal (quartz) spectrograph was used and intensities were photographically recorded.
- 3a. Spectra and tabular data are presented.
- 3b. The effect of a chemical bond on the X-ray spectra was obtained for the rare earths.
- 3c. Transitions are discussed.

(34)E

Tsutsumi, K., FINE STRUCTURES OF X-RAY K ABSORPTION SPECTRA OF Ni IN OXIDES OF Ni. J. Phys. Soc. Japan 13 (6), 586-590 (1958).

(34)E Cont'd.

1. Ni in NiO, Ni<sub>2</sub>O<sub>3</sub>, and NiO<sub>2</sub> in H<sub>2</sub>O were studied.
2. A bent crystal (quartz) spectrograph was used and the spectra were photographically recorded.
- 3a. The first absorption maximum increased in intensity with increasing oxygen content while other features of the spectra remained essentially unchanged.
- 3b. The results are tabulated and spectra are presented.
4. The results support the Coster and Kiestra theory of absorption spectra.

(35)E

Vainshtein, E. E., M. N. Brill and I. B. Staryi, FINE STRUCTURE OF THE K ABSORPTION SPECTRA OF Ti IN TITANATES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 122, 201-204 (1958). Trans: Sov. Phys. "Doklady" 3, 947-948 (1958).

1. Titanates of Mg, Ca, Ba, Sr, Fe, and Zn were studied.
2. A bent crystal (quartz) spectrograph was used to study absorbers 3-14 mg/cm<sup>2</sup> thick; spectra were recorded photographically.
- 3a. The long-wave absorption band resulting from 1s electron transitions to 3d free levels is a singlet.
- 3b. All spectra are presented.
4. In perovskite types, the Ti edge depends strongly on the polarization of atoms in the compound.

(36)E

Vainshtein, E. E., I. B. Staryi and E. A. Zhurakovskii, THE FINE STRUCTURE OF TITANIUM K ABSORPTION SPECTRA IN CARBIDES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 122, 365-366 (1958). Trans: Sov. Phys. "Doklady" 3, 960-961 (1958).

1. Titanium with a carbon content varying from 12-24% and also TiO<sub>2</sub> were studied.
2. A bent crystal (quartz) spectrograph was used; intensities were recorded photographically.
3. The fine structure of the titanium K absorption remains unchanged over the range of carbon contents where a single phase FCC metallic atom lattice exists.
4. The bonds in TiC are not metallized.

1958 (C)

(C-1)T

Bilz, H., ELECTRONIC STATES OF HARD SUBSTANCES WITH THE NaCl STRUCTURE. (In German.) Z. Physik 153, 338-358 (1958).

1. Band structure data for MX compounds of the transition metals is presented.
2. The one electron model was used for hard phase electronic bands.
- 3a. Band structure data and bonding models are

shown.

- 3b. Calculated data for Ti, Zr, Hf, V, Nb, Ta and their carbides, oxides, and nitrides are tabulated and compared with experimental results where possible.

(C-2)T

Brooks, H., and F. S. Ham, ENERGY BANDS IN SOLIDS-THE QUANTUM DEFECT METHOD Phys. Rev. 112, 344-361 (1958).

1. Electron energy bands in Na, Li, K, Rb, and Cs were calculated from spectroscopic data for the free atom.
- 2a. Explicit construction of one-electron potential was avoided in representing the interaction between valence and core electrons.
- 2b. Interaction between the valence electrons and an ion in the crystal was assumed to be about the same as in the free atom.
3. Tables of the data including improved polarization corrections are given.

(C-3)T

Callaway, J., ELECTRON ENERGY BANDS IN SODIUM. Phys. Rev. 112, 322-325 (1958).

1. Energy levels of s and p type symmetry were determined at four points in the Brillouin zone.
3. The potential energy of valence electrons is represented in Na by:  $V(r) = -2/r + A[\exp(-\beta r)/r]$ ,  $A[\exp(-\beta r)/r]$  is repulsive and represents core electrons, A and  $\beta$  are obtained from spectral data.

(C-4)E

Chupp, E. L., J. W. M. DuMond, F. J. Gordon, R. C. Jopson and H. Mark, K SERIES X-RAY WAVELENGTHS IN RARE EARTH ELEMENTS. Phys. Rev. 112, 1183-1186 (1958).

1. The K series in Nd, Sn, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu was studied.
2. A 2-meter radius bent crystal (quartz) spectrograph was used, with photographic recording, and a 3.7 MEV proton accelerator for excitation.
- 3a.  $K\alpha_1$ ,  $K\alpha_2$ ,  $K\beta_1$ , and  $K\beta_3$  lines are tabulated.
- 3b. Weak transitions,  $K\beta_5$  and  $K\gamma_3$ , were found.

(C-5)T

Deslattes, R. D., 3d ELECTRONS IN TRANSITION METALS. Phys. Rev. 110, 1471 (1958).

1. The Weiss-DeMarco data (Ref. #C-24, 1958) are discussed.

(C-6)T

Dutta, A. K., SOFT X-RAY EMISSION SPECTRUM OF GRAPHITE AND THE SUGGESTION OF A SUITABLE BRILLOUIN ZONE FOR IT. Indian J. Phys. 32, 397-399 (1958).

1. Skinner's spectrum for graphite was used.
3. The 4 electron zone was suggested as most suitable.
4. Known  $\sigma$  and  $\pi$  electron interaction in C-C bonds of graphite supports the 4 electron zone view.

(C-7)T

Flodmark, S., ELECTRON DISTRIBUTION AND ENERGY BANDS IN CRYSTALS OF METAL BORIDES OF THE TYPE MB<sub>6</sub>.  
Arkiv Fysik 14, 513-550 (1958).

1. The distribution of the boron valence electrons in MB<sub>6</sub> metal borides is described.
- 2a. Hybridized s, p and d orbitals of the atomic L and M shells were used to construct Bloch wave functions.
- 2b. The one-electron approximation equations were solved numerically.
- 3a. Energy eigenvalues and eigenvectors for bonding orbitals in L and LM approximations are tabulated.
- 3b. Several diagrams of the MB<sub>6</sub> bonding orbitals and structures are shown; an energy level diagram is also included.
4. The M shell orbitals are essential for many of the strongly bonded orbital sites.

(C-8)T

Friedel, J., ELECTRONIC STRUCTURE OF TRANSITION METALS AND ALLOYS AND OF HEAVY METALS.  
(In French.)  
J. Phys. Radium 19, 573-581 (1958).

1. Electronic structures of transition metals dissolved as impurities in Cu or Al are discussed and these metals are compared with those of the 4f and 5f series.
4. Magnetic properties of transition metals and rare earths are the result of an equilibrium of exchange couplings.

(C-9)E

Gauthe, B., ENERGY LEVELS OF ELECTRONS PASSING THROUGH METAL FOILS - COMPARISON WITH RESULTS OF X-RAY SPECTROSCOPY. (In French.)  
Ann. Phys. (13) 2, 915-964 (1958).

1. Selected metal foils were studied to find if a relation exists between spectral distribution of energy losses observed in electrons and the absorption pattern of X-ray spectra.
3. Two elementary interactions producing energy losses exist - individual collisions and plasma oscillations.
- 4a. Correspondence of the X-ray absorption maximum with respect to the peak of the emission band and the value of the electron loss indicates individual character originating in the elementary interaction.
- 4b. Non-correspondences indicate plasma oscillations.

(C-10)T

Horak, Z., CALCULATIONS OF EXCITED STATES OF ATOMS.  
Czech. J. Phys. 8, 271-276 (1958). (In English.)

1. Approximate wave functions of the excited states of a many electron atom and also the K X-ray state of neon were calculated.
- 2a. The many electron calculations were made by means of the extremalization of the variation functional.
- 2b. The X-ray state calculations were made by radial wave functions in Morse's analytical form.

4. The method can be used to interpret some results of soft X-ray spectroscopy.

(C-11)T

Kittel, C. and W. Marshall, 3d ELECTRONS IN IRON.  
J. Chem. Phys. Solids 6, 99 (1958).

- 1,2. The Weiss-DeMarco data (Ref. #C-24, 1958) is discussed in terms of spectroscopic splitting factor (g) and the magneto-mechanical ratio (g').
4. It may be possible to reconcile (g-2) and (2-g') values from other sources with the Weiss-DeMarco data.

(C-12)T

Lesnik, A. G., INTERATOMIC INTERACTION IN Fe-Cr SYSTEM ALLOYS. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 122, 385-388 (1958).  
Trans: Sov. Phys. "Doklady" 3, 1006-1009 (1958).

1. It was hypothesized that the formation of a polar state of atoms in alloys occurs.
2. Statistical theory was used to support this hypothesis.
3. Features of the disintegration of the solid solution accompanied by separation of an intermetallic compound of the  $\sigma$  phase type are postulated.

(C-13)T

Mokhov, V. N. and M. G. UrIn, AUGER EFFECT IN HEAVY ATOMS. (In Russian.)  
Zhur. Eksptl. Teoret. Fiz. 30, 209-210 (1958).  
Trans: Sov. Phys. "JETP" 3, 133 (1958).

1. A new equation for  $\omega_k$ , the coefficient of the Auger effect, was derived.
3. For Ag, the formula gives  $\omega_k = 1.14 \times 10^6$  and experiment gives  $\omega_k = 1.12 \times 10^6$ .

(C-14)T

Morin, F. J., OXIDES OF 3d TRANSITION METALS.  
Bell System Technical Journal 37, 1047-1084 (1958).

1. Magnetic, electrical, and optical properties were examined in 3d metal oxides and an energy band scheme is proposed for the oxides of Sc, Ti, and V, suggesting that the non-bonding 3d orbitals of neighboring cations overlap to form a 3d conduction band.
- 3a. The 3d orbitals do not overlap in the other 3d elements, so that the 3d electrons are in isolated energy states and electron transport occurs by electron exchange between cation neighbors and involves an activation energy.
- 3b. Energy level diagrams are presented.

(C-15)T

Onaka, R., GRATING MOUNTING FOR A VACUUM ULTRA-VIOLET MONOCHROMATOR.  
Science of Light (Tokyo) 7, (2) 23-27 (1958).

- 1,3a. The rotation of a concave grating about a point displaced from the center of the grating is applicable to a monochromator of any angle of deflection.



(C-15) Cont'd.

- 3b. A general analysis of such a mounting is presented and its usefulness down to 510A is illustrated.
- 3c. The optical arrangement for the monochromator is presented.

(C-16)T

Pearson, W. B., GROUP VB TO VIIB INTERMETALLIC CRYSTAL STRUCTURES.  
J. Chem. Phys. Solids 7 (1), 65-77 (1958).

- 1. Crystal structures of VB and VIIB elements and compounds are discussed on the basis of valence bond theory.
- 2. A bond scheme is proposed and it is used to derive qualitative bond structures for these elements.
- 3a. The derived bond structures deviate from the usual semiconductor model.
- 3b. Bonding is discussed in detail.

(C-17)T

Plass, G. N., MODELS FOR SPECTRAL BAND ABSORPTION.  
J. Opt. Soc. Am. 48, 690-703 (1958).

- 1. Models used to represent band absorption are compared and regions of validity for each model are given.
- 3. Absorption of a statistical model including effects of overlapping is shown to depend only on an average equivalent width for a single line.

(C-18)T

Robins, D. A., BONDING IN CARBIDES, SILICIDES AND BORIDES.  
Powder Metallurgy 1958 (1,2) 172-188.

- 1. A relationship between the coordination of the metal atoms and the number of bonding electrons per atom is proposed.
- 3a. The crystal structure and stability of carbides is discussed in terms of the electron concentration.
- 3b. In silicides Si-Si bonds are important; in the disilicides no metal-metal bonds remain.
- 3c. Boron-boron bonds are responsible for boride bonding.
- 3d. Tables of calculating parameters are presented.

(C-19)T

Takeishi, Y., AUGER EJECTION BY NICKEL.  
J. Phys. Soc. Japan 13, 766 (1958).

- 1. The total electron yield for  $\text{He}^+$ ,  $\text{Ne}^+$ ,  $\text{A}^+$ , and  $\text{Xe}^+$  was computed.
- 3a. Results are tabulated.
- 3b. Secondary electrons are discussed.

(C-20)T

Tomboulion, D. H. and D. E. Bedo, SPECTRAL CHARACTERISTICS OF THE RADIATION EMITTED BY ELECTRONS ACCELERATED IN A SYNCHROTRON.  
J. Appl. Phys. 29 (5) 804-809 (1958).

- 1,2. Expressions were developed for the average power radiated by a high-energy electron moving in a circular orbit. The instantaneous electron energy  $E(t)$  is assumed to vary with

the time in accordance with  $E(t) = E_m \sin^2(\pi t/2T)$ .

- 3a. The results are presented in a form which is applicable to any synchrotron in which the time dependence of electron energy is as stated above.
- 3b. Spectral distributions are obtained corresponding to the radiation emitted over a partial or full acceleration interval.
- 3c. The numerical results predicted from the general relations are examined for a particular value of the peak energy  $E_m = 6.0$  Bev and the orbital radius  $R = 86.14$  ft. In the case of these parameters, the continuous spectrum attains a peak at 0.36A.
- 4. Calculations related to the case where the radiation is collected only over the low-energy portion of the acceleration interval, indicate that it is feasible to utilize the continuum as a source for measurements in problems of interest to astrophysics and solid state spectroscopy.

(C-21)T

Toyozawa, Y., LINE SHAPES OF EXCITON ABSORPTION BANDS.  
Prog. Theoret. Phys. (Kyoto) 19, 214 (1958).

- 1a. Theoretical considerations and experimental difficulties are discussed.
- 1b. Earlier work is reviewed.

(C-22)T

Toyozawa, Y., LINE SHAPES OF EXCITON ABSORPTION BANDS.  
Prog. Theoret. Phys. (Kyoto) 20, 53-81 (1958).

- 1. The general theory of these line shapes is developed.
- 2. A generating function method is used.
- 3a. The absorption band is Lorentzian if the temperature is not too high and the coupling is weak.
- 3b. If the coupling is strong and the temperature is high, the band is Gaussian.

(C-23)T

Trost, W. R., ORBITAL THEORY IN THE TRANSITION METALS.  
Canadian Dept. Mines Tech. Surveys, Mines Branch Res. Repts. R42, 77 pp. (1958).

- 1. See Ref. #C-25 (1959) for annotation.

(C-24)E

Weiss, R. J. and J. J. Demarco, 3d ELECTRONS IN Cu, Ni, Co, Fe, and Cr.  
Revs. Modern Phys. 30, 59-62 (1958).

- 1. Data on 3d electron population in the iron group transition metals is presented.
- 2a. Absolute X-ray scattering factors are measured.
- 2b. The argon core as calculated by the self-consistent field method for the free atom is subtracted from the measured scattering data leaving only the unbound electron contribution.
- 3a. The radial extension of 4s and 4p electrons is such that all their scattering factors are negligible at all Bragg angles; this leaves

(C-24)E Cont'd.

only the 3d contribution.

3b. The 3d populations found are tabulated.

1959

(1)E

Bally, D. and L. Benes, FINE STRUCTURE OF X-RAY ABSORPTION DISCONTINUITIES OF NICKEL AND IRON IN Ni-Fe ALLOYS. (In French.) Compt. Rend. (French Academy) 248, 2327-2329 (1959).

1. Alloys ranging from 50-100% Ni were studied.
2. A bent crystal (mica) spectrograph was used in the second order and intensities were photographically recorded.
3. Results are tabulated but no spectra are shown; nine features of the observed spectra are listed.

(2)E

Bally, D. and L. Muller, FINE STRUCTURE OF THE K ABSORPTION EDGE OF NICKEL AND IRON IN Ni-Fe ALLOYS AT LOW TEMPERATURES. (In French.) Compt. Rend. (French Academy) 249, 1099-1101 (1959).

1. The fine structure was determined at 113°K.
2. A crystal spectrograph was used.
- 3a. For the Fe-Ni alloys a general shift of the K-absorption structure towards longer wavelengths was observed.
- 3b. Detailed results are tabulated.

(3)E

Bedo, D. E. and D. H. Tomboulion, THE  $M_{2,3}$  EMISSION BAND OF COPPER. Phys. Rev. 113, 464-470 (1959).

1. The  $M_{2,3}$  band in thin evaporated films of high purity Cu was studied.
- 2a. A grating spectrometer was used at grazing incidence with 200 ma at 1500V (300 watts) power input to the target which was at a pressure of  $10^{-6}$  mm Hg.
- 2b. Fresh Cu was put down every 15 minutes, and the total time for the photographic exposure was 6 hours.
- 3a. The distortion of the band due to window effects, self-absorption, the presence of contaminants, and the nature of the target is discussed as are satellites.
- 3b. Spectra are shown and data are tabulated; The band has a maximum at 72 eV (172A), and a width of 7.8 eV; at the high energy end the intensity rises gradually and no sharp bands are noticeable.

(4)E

Bonnelle, C., L SPECTRA OF COPPER IN  $Cu_2O$  and  $CuO$ . Compt. Rend. (French Academy) 248, 2324-2326 (1959). (In French.)

1. Both the emission and absorption spectra were studied.
2. A curved crystal spectrometer was used.

- 3a. The  $L\alpha$  is narrower and displaced 0.7 eV toward lower energies in  $Cu_2O$  as compared with Cu.
- 3b. In  $CuO$ , the displacement is 0.3 eV toward lower energies.

(5)E

Borisov, M. D. and V. V. Nemoshkalenko, THE STRUCTURE OF THE ENERGY SPECTRA OF ELECTRONS IN Fe-Cr, AND Fe-Cr-Ni ALLOYS. (In Russian.) Fiz. Metal. i Metallovedne 8, 211-215 (1959). Trans: Physics of Metals and Metallography 8 (In Process)

1. The  $K\beta_5$  line of Cr, Fe, and Ni and also the  $K\beta_1$  were studied.
2. A crystal spectrometer was used.
- 3a. The  $K\beta_5$  is dependent upon electron transitions from the conduction band to the K level, and the  $K\beta_1$  is dependent upon electron transitions from the 3p level to the K level.
- 3b. The Fermi energies of Fe-Cr alloy and Fe-Cr-Ni alloy were 0.19 v/R and 0.22 v/R respectively.

(6)T

Borovskii, I. B. and K. P. Gurov, EFFECT OF IMPURITIES ON X-RAY SPECTRA OF TRANSITION METALS. (In Russian.) Zhur. Eksptl. i Teoret. Fiz. 36, 1203-1206 (1959). Trans: Sov. Phys. "JETP" 9, 856-858 (1959).

1. Regional perturbation is created from impurity charges in the electron shells of transition metals. This amounts to induced surplus charge, opposite in sign to that of the impurity and forming a dipole with it.
2. An integral equation is set up for this surplus charge.
3. This equation is applied to the particular case of  $\alpha$ -Fe.

(7)E

Borovskii, I. B. and K. P. Gurov, ELECTRONIC SPECTRA OF DILUTE SOLID SOLUTIONS. (In Russian.) Fiz. Metal. i Metallovedne 7, 225-234 (1959). Trans: Physics of Metals and Metallography 7, (2), 61-70 (1959).

1. Cr, and Pb-Sn and Cr-Mo alloys were studied at -196° and 300°C by investigating the K absorption spectrum of these materials.
2. A bent crystal transmission spectrograph with a dispersive power of 4 XU/mm was used; intensities were recorded photographically.
- 3a. Addition of Mo to Cr increased the energy of  $M_{2,3}$  levels in Cr and did not affect the K spectrum.
- 3b. An atom block formation is postulated for dilute solid solutions at 0°K.
4. The formation of interatomic bonds in alloys causes energy state distribution changes for the valence shell, and thermal vibrations exert a very large influence on the entire electron-energy spectrum.

(8)E

Borovskii, I. B. and V. V. Schmidt, INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE FINE STRUCTURE OF THE MAIN K EDGE IN THE ABSORPTION SPECTRUM OF IRON. (In Russian.)

(8)E Cont'd.

Doklady Akad. Nauk S.S.S.R. 127, 997-1001 (1959). Trans: Sov. Phys. "Doklady" 4, 855-858 (1960).

2. A double crystal (calcite) spectrometer was used in the (1,+1) position to study 7 micron iron foils heated by self-resistance at  $5 \times 10^{-6}$  mm Hg pressure; spectra were recorded electronically.
- 3a. The energy loss of an electron was  $7.5 \pm 0.7$  eV for  $\alpha$  - Fe and  $1.0 \pm 0.6$  eV for  $\gamma$  - Fe; these values were temperature independent.
- 3b. Actual and corrected spectra are shown.
4. The fine structure of the short wave region and its temperature dependence can be ascribed to the excitation of plasma oscillations in the electron cloud of the metal.

(9)E

Catterall, J. A. and J. Trotter, INTERPRETATION OF X-RAY EMISSION SPECTRA. Phil. Mag. (8) 2, 1424-1431 (1959).

1. The K satellite emission bands in Li and Be were studied.
2. A grating spectrometer was used and the spectral intensities were recorded by means of a Be-Cu photomultiplier.
3. There is probably a hole occurring in the core-level when the soft X-ray emission process takes place.
4. This hole is unlikely to have a great effect on the intensity distribution of the spectra.

(10)E

Catterall, J. A. and J. Trotter, SOFT X-RAY EMISSION SPECTRA FROM LITHIUM AND Li-Mg ALLOYS. Phil. Mag. (8) 4, 1164-1170 (1959).

2. A grating spectrometer was used at grazing incidence and photons were counted with a Be-Cu photomultiplier.
- 3a. In the alloys, electron transfer took place from Mg to Li.
- 3b. The shape of the high energy edge of the Li-K emission spectrum was explained by broadening of the 1s ionic level in the crystal.

(11)E

Callon, P., STUDY OF THE K-EMISSION BAND OF MAGNESIUM. (In French.) Compt. Rend. (French Academy) 248, 1985-1987 (1959).

1. Both metallic Mg and MgO were studied.
2. A curved crystal (25 cm. radius mica in the second order) spectrograph was used and intensities were photographically recorded.
- 3a. Spectra and tabular results are presented.
- 3b. Oxide and metal bands are compared and effects of oxidation on the emission band of metallic Mg were found.

(12)E

Callon, P., EMISSION  $L\beta_2$  AND ABSORPTION  $L_3$  OF MOLYBDENUM. (In French.) Compt. Rend. (French Academy) 248, 2085-2087 (1959).

1. Samples of 1000A films of Mo evaporated onto Al supports were studied.
2. A curved crystal spectrograph was used and intensities were photographically recorded.
- 3a. The half-width value of the  $L\beta_2$  diminished as the excitation potential was increased; the half-width maximum was  $5 \pm 0.2$  eV with an index of asymmetry of 1.2.
- 3b. Superimposed on the  $L\beta_2$  was a strong 'white' line attributed to vacancies in the 4d band.
- 3c. The minimum was 6 eV from the  $L\beta_2$  peak.

(13)E

Collet, V., THE  $L_3$  X-RAY ABSORPTION SPECTRA OF COMPLEX SALTS OF PLATINUM. (In French.) Compt. Rend. (French Academy) 248, 1314-1316 (1959).

1. Some 20 complex salts of Pt were studied.
2. A special X-ray tube at 20 kV, 7.5 ma equipped with a Ta target was used; the spectra were recorded photographically.
3. All results are tabulated.

(14)E

Collet, V., CONTRIBUTION TO THE STUDY OF THE NATURE OF TRANSITION METAL COMPLEXES BY X-RAY SPECTROGRAPHY. (In French.) These Doct. Sci. Phys. Paris 1959, 52 pp. (1959)

1. The K spectra of Ni, Co, and the L spectra of Pt, Au, and Re in complexes were studied.
2. A Cauchois (bent crystal) spectrograph was used; intensities were recorded photographically.
3. The electronic configuration for the transition metals when they are in complexes was determined.

(15)E

Deslattes, R. D. and H. S. DeBen, THE K ABSORPTION EDGE OF SELENIUM. Phys. Rev. 115, 71-74 (1959).

1. Thin unsupported films of Se which had been evaporated onto rock salt and which were amorphous were investigated.
2. A double crystal (quartz) spectrometer was used; intensities were measured with a NaI scintillation counter.
3. The gap energy is about 4 eV indicating that the lower portion of the conduction band contains low p type symmetry.
4. The edge absorption maximum arises from transitions to X-ray excitation states in the region of the forbidden energy gap.

(16)E

Dowdey, J. E., FINE STRUCTURE OF THE X-RAY ABSORPTION EDGE OF CUBIC FERRITES. Univ. Microfilms MIC-59-154, 99 pp. (1959). Diss. Abs. 19, 2365.

1. The  $M-Fe_2O_4$  spinel structure type ferrites were studied.
2. A double crystal spectrometer equipped with a scaler was used to obtain intensities.



(16)E Cont'd.

3. The fine structure is interpreted as a composite of electron transitions from 1s to 3d, 4s, 4p, and np levels.
4. Hybridization of the orbitals gave some p character to the 3d and 4s bands so that no violation of the selection rules occurred.

(17)T

Dutta, A. K., AN ANALYSIS OF THE SOFT X-RAY EMISSION SPECTROSCOPY OF GRAPHITE AND AN APPROPRIATE ELECTRONIC PICTURE OF IT.  
Proc. Phys. Soc. (London) 74, 604-608 (1959).

2. Skinner's soft X-ray spectrum for graphite was used in performing the analysis.
- 3a. The Brillouin zone is bounded by two independent sets of planes with overlapping electrons (into the next zone).
- 3b. The total bandwidth is  $24 \pm 3$  eV.
4. The zone is of the four electron variety because a correlation of K states with the soft X-ray spectra gives the correct value for the Fermi surface boundary.

(18)E

Dyson, N. A., CONTINUOUS X-RAY SPECTRUM FROM ELECTRON OPAQUE TARGETS.  
Proc. Phys. Soc. (London) 73 (6) #474, 924-936 (1959).

1. The angular and energy distributions for the continuous X-ray spectrum were investigated in the forward hemisphere.
- 2a. Exciting voltages were 6 and 12 kv.
- 2b. The technique and conditions are carefully described.
- 3a. The angular distribution was greatly affected by X-ray scattering.
- 3b. The absolute efficiency of X-ray production was 20% greater than that predicted by the Compton-Allison formula.
- 3c. The results are tabulated.

(19)E

Guseva, L. N. and B. I. Ovechkin, ATOMIC SCATTERING OF X-RAYS IN SOLID SOLUTIONS OF COPPER AND NICKEL. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. - Otdel. Tekh. Nauk, Met. i Toplivo 1959 (2), 82-85.  
Annotation from Chem. Abs. 53 - 17661i.

1. Only the technique is discussed - data are not interpreted.
2. Data are obtained from X-ray powder photographs taken by the exchange method at angles of 20, 35, 40, and 60° at 2-3 hour exposure times.

(20)E

Hayashi, T. and H. Kawaharada, CRITICAL POTENTIALS OF SOFT X-RAYS EMITTED FROM IRON.  
Sci. Repts. Tohoku Univ. First Ser. 43, 1-5 (1959).

1. The critical potentials were measured and the excitation voltages were calculated; good agreement was obtained.

2. The energies of quasi-stationary states were determined from the measured fine structure of K and M spectra of iron.
3. Exciting voltages of the s or p core electrons to the quasi-stationary states of s, p, or d symmetry are estimated.
4. The absorption maxima in the fine structure of the soft X-ray absorption spectrum of a solid are caused by the excitation of core electrons to quasi-stationary states. There is a close relationship between the quasi-stationary states and the critical potentials.

(21)T

Kakushadse, T. I., SATELLITES OF  $K\alpha_3$  AND  $K\beta_1$  IN X-RAY SPECTRA. (In German.)  
Ann. Physik (7) 2, 352-359 (1959).

1. The effective interaction of the electrons with thermal lattice vibrations is considered.
- 2,3. The Bloch theory is extended to explain the occurrence of  $K\alpha_3$  and  $K\beta_1$  satellites.

(22)E

Kawaharada, H., CRITICAL POTENTIALS OF SOFT X-RAYS EMITTED FROM NICKEL.  
Sci. Repts. Tohoku Univ. First Ser. 43, 143-147 (1959).

1. The energies of quasi-stationary states were determined from the measured fine structure of K and  $M_{2,3}$  absorption spectra of Ni.
- 3a. Excitation voltages of the s or p core electrons to the quasi-stationary states of s, p, or d symmetry are estimated.
- 3b. The critical potentials and the calculated excitation voltages are tabulated; these are in good agreement.
4. There is a close relationship between the quasi-stationary states and the critical potentials.

(23)E

Kazantsev, V. A., STUDY OF THE Mn- $K\beta$  SPECTRUM IN THE Mn-Ni SYSTEM. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 123, 449-452 (1959)  
Trans: Sov. Phys. "Doklady" 2, 1249-1253 (1959)

1. Alloys with a Ni content varying from 40.1 - 92.43 w/o were studied.
- 2a. A bent crystal spectrograph was used; samples were in the shape of tablets pressed into the Cu head of the X-ray tube anode.
- 2b. The specimen temperature was measured during the run, and X-ray intensities were recorded photographically.
3. Tables and spectra showing the behavior of Mn- $K\beta_5$  bands as a function of composition, temperature and magnetic state of the alloy are presented.
4. The Mn- $K\beta_5$  is not affected by compositional changes, but the Mn $K\beta_5$  shifts 1.2 - 1.8 eV toward lower energies as the temperature is elevated and the magnetic transition affects the Mn- $K\beta$  drastically.

(24)E

Kazantsev, V. A., STUDY OF THE  $K\beta_5$  BAND AND K ABSORPTION EDGE IN NICKEL ON PASSING THROUGH THE CURIE POINT. (In Russian.)  
Doklady Akad. Nauk S.S.S.R. 123, 667-670 (1959)  
Trans: Sov. Phys. "Doklady" 2, 1262-1265 (1959)

1. Tablets of 99.99% Ni pushed into the anode of the X-ray tube were investigated; work was carried out at 300-400°C and not in immediate proximity to the Curie point.
- 2a. A bent crystal spectrograph of 3.92 XU/mm dispersive power was used; microphotograms of the spectra were obtained in the first and second order.
- 2b. For absorption spectra, a 5-6 $\mu$  sheet was used and the temperature was measured with a nichrome-constantan thermocouple; temperatures used were 22, 320, and 400°C  $\pm 5^\circ$ .
3. The transition to the paramagnetic state shifts the  $K\beta_5$   $2.1 \pm 0.2$  eV toward higher energies and decreases the bandwidth by  $1.8 \pm 0.4$  eV.
4. The Ni-K edge shifts about 1.2 eV toward higher energies as the temperature is increased.

(25)E

Lucasson-Lemasson, A., A NEW STUDY OF THE L ABSORPTION SPECTRUM OF GERMANIUM. (In French.)  
Compt. Rend. (French Academy) 248, 1156-1158 (1959).

1. Both the L absorption and emission spectra of evaporated films of Ge were studied.
- 2a. A bent crystal (gypsum) spectrograph was used and intensities were photographically recorded.
- 2b. The absorber thickness ranged from 0.1 to 1 micron; the temperature varied from 20 - 400°C.
3. Results and spectra are tabulated.
4. The spectra are greatly influenced by the crystalline state of Ge, which was checked by electron diffraction; evidence of this is presented.

(26)E

Nemnonov, S. A. and K. M. Kolobova, THE X-RAY K-ABSORPTION SPECTRUM OF IRON AT LIQUID NITROGEN TEMPERATURE. (In Russian.)  
Fiz. Metal. i Metallovedne 8, 478-480 (1959).  
Trans: Physics of Metals & Metallography 8. (In Process.)

2. A crystal spectrometer was used.
3. The middle of the basic K-edge curve shifted into the long wavelength region.
4. As a result of lattice parameter decrease, the 3d, 4s and 4p band overlap of metallic iron increases. Thus, the d state redistribution is altered according to the energy and probability of the corresponding transformations. As a result, the Fermi surface energy can also decrease.

(27)E

Nikolaeva, L. G. and S. M. Karal'nik, CHARACTERISTIC ABSORPTION OF X-RAYS IN BINARY ALLOYS OF IRON WITH Ni, Co, AND Cr. (In Ukrainian.)  
Ukrain. Fiz. Shur. 4, 260-267 (1959).  
Annotation from Chem. Abs. 53 - 21133h.

1. The change in the K absorption edge of Fe upon alloying with Ni, Cr, and Co was investigated.
- 3a. The greatest change in the spectra of these alloys occurs at the K edge.
- 3b. An attempt is made to interpret the results on the basis of external screening occurring when the interatomic bond changes.

(28)E

Nordling, C., ENERGY SHIFTS IN 5TH PERIOD L SHELLS DUE TO OXIDATION AND ALLOYING.  
Arkiv Fysik 15 (3), 241-250 (1959).

- 1,2,3,4. Cd-CdO: Thin transmission and thick reflection sources were prepared. The evaporated metal layers were heated in air for 12 hrs. at 200°C to obtain CdO. To check compositions, electron diffraction patterns were taken; these showed pure Cd and complete oxidation in the CdO samples. The  $L_1$  and  $L_3$  energy shifts were measured with Cu-K $\alpha_1$  radiation (to produce photoelectrons).  
Results:  $L_1$  : shift =  $-0.8 \pm 0.3$  eV  
 $L_3$  : shift =  $-0.6 \pm 0.3$  eV  
Minus sign indicates that the electron binding energies are smaller in CdO than in Cd.  
Sn-SnO:  $L_1$ ,  $L_2$ ,  $L_3$  shifts were measured. Samples were prepared as above. Samples were pure.  
Results:  $L_1$  : shift =  $+1.3 \pm 0.3$  eV  
 $L_2$  : shift =  $+1.1 \pm 0.3$  eV  
 $L_3$  : shift =  $+1.3 \pm 0.2$  eV

Plus sign indicates an increase in L binding energies due to oxidation contrary to the case of Cd.

Sn-SnO<sub>2</sub>: Reflection samples only:

$L_3$  only : shift =  $+1.1 \pm 0.3$  eV

Samples contained less than 0.3% impurities.  
Sn-SnAu: In the case of an alloy, it is most advantageous to have thick converters since the techniques of evaporating or electroplating alloys without changing the composition are not too reliable. The alloy was prepared by heating 50 a/o Sn and 50 a/o Au in evacuated pyrex tube to well above M.P. (418°C). In Sn $L_3$ , no shift was observed due to alloying.  
Conclusions: The magnitude of the shifts in Cd and Sn are less than in Cu and the  $L_1$  shifts are not significantly greater than  $L_2$  or  $L_3$  shifts. For Cu, the widths of L photo lines are a few tenths of an eV greater in the oxide; this is also true in Sn and is always less than 0.5 eV. The Fermi level in CdO lies about 0.4 eV below the conduction band.

Parrat, L. G., - See Review (R-9) and (R-10).

(29)E

Porteus, J. O., THE K ABSORPTION SPECTRA OF ALKALI METAL CHLORIDES.  
Univ. Microfilms MIC 59-135, 155 pp. (1959).  
Diss. Abs. 19 - 2368.

1. LiCl, RbCl, and CsCl were studied.
2. A double crystal spectrometer equipped with a proportional counter was used.
- 3a. Spectra and tabular data are presented.
- 3b. The spectra are discussed from the point of view of X-ray excitation states.

(30)E

Porteus, J. O. and L. G. Parratt. AN OPTIMIZED METHOD FOR CORRECTING FOR SMEARING ABERRATIONS: COMPLEX X-RAY SPECTRA.  
Office of Technical Services PB143952, 130 pp. (1959).

- 1,2. A convolution integral is set up in order to obtain the true spectrum  $T(V)$  from the observed spectrum  $O(V_n)$  for KCl.
- 2a. The observed spectrum was assumed to come from a spectrometer having a smearing function equal to  $M(V_n - V)$ . An attempt is made to correct for this smearing effect also.
- 3a. It is shown that
$$O(V_n) = \int_0^\infty T(V)M(V_n - V)dV$$
- 3b. The correction method is applied to the K absorption and emission spectra of solid KCl.

(31)E

Rumyantsev, I. A. and M. I. Korsunskii, INVESTIGATION OF THE L SPECTRA OF Zn IN ALLOYS OF THE Cu-Zn SYSTEM. (In Russian.)  
Optika i Spektroskopiia, 7, 850-852 (1959).  
Trans. Optics and Spectroscopy 7, 498-500 (1959).

1. Alloys comprised of each phase of the Cu-Zn system and pure Cu and Zn were studied.
2. A bent crystal spectrograph (mica) was used; intensities were recorded photographically with exposure times ranging from 2-6 hours.
3. Spectra for each alloy studied are presented showing the differences observed; no explanation or discussion of the data is given.

Sandstrom, A. E., - See Review (R-12).

(32)E

Sokolowski, E., ELECTRON BINDING ENERGIES OF IV AND VI PERIOD ELEMENTS BY PHOTOELECTRON METHOD.  
Arkiv Fysik 15, 1-30 (1959).

- 1,2,3,4. The binding energy of an inner electron shell is the energy associated with an

electron transition from that inner shell to the lowest unoccupied level in the conduction band. Under the assumption of a constant density of states around the first unoccupied level, the absorption edge should follow an arc tan function, the inflection point of which should correspond to transitions to the lowest unoccupied state in the conduction band. Since the binding energy corresponds to a transition from the given shell to the lowest unoccupied level in the atom, the quantum numbers vary for the final state and a discontinuity must be expected in the modified Moseley diagram each time an outer shell is filled and the symmetry of the lowest unoccupied level is changed. The K binding energy of 4th period elements is a sensitive function of the crystal parameters.

(33)E

Sokolowski, E. and C. Nordling, EXPERIMENTAL STUDIES OF KLL AUGER SPECTRA OF Cu AND Ge.  
Arkiv Fysik 14, 557-564 (1959).

- 1,2,3,4. The sample was an evaporated metal layer 100A thick. The intensity of the satellites was found to be a function of source thickness. Table I gives KLL Auger energies for Cu (p. 560 of paper); Table II gives KLL Auger energies for Ge (p. 561); a table giving relative energy and intensity of lines is presented (p. 562). For the energies, a set of general equations are given which depend on B.E. of the atomic shells involved and a group of functions F and G, accounting for screening and exchange energy:
$$F \text{ (or } G) = A (Z - Z_s)(1 - \alpha Z^2)$$
where A,  $Z_s$  and  $\alpha$  are constants (values not given). A comparison between theory and experiment regarding absolute energies for the Auger lines is not good, the calculated energies being 40 and 50 eV too low for Cu and Ge respectively. The discrepancy must be sought in the functions F and G, to which the absolute energies are more sensitive than the relative values.

(34)E

Soules, J. A. and C. H. Shaw, X-RAY K ABSORPTION SPECTRA OF SOLID ARGON AND KRYPTON.  
Phys. Rev. 113, 470-472 (1959).

1. The absorption edge of Ar and Kr in the solid and gaseous states was studied.
2. A double crystal (calcite) spectrometer was used; photons were counted by a Xe-CH<sub>4</sub> proportional counter.
- 3a. A great deal of fine structure was found in the solid state samples.
- 3b. The broad absorption maxima are correlated with valence bands; the extremely sharp initial rise indicates the existence of excitation states.
- 3c. The argon level width is 0.58 eV.
- 3d. Actual spectra are presented.

Tomboulia, D. H., - See Review (R-16).



(35)E

Tomboulia, D. H., A PHOTON COUNTING SPECTROMETER FOR ATTENUATION MEASUREMENTS IN THE SOFT X-RAY REGION. U.S. At. Energy Comm. NP-7906, 20 pp. (1959).

- 1,2. Aluminum and zapon absorber foils were used under normal illumination at 180A and a Be-Cu photomultiplier was rotated from 0-22° with respect to the foil axis to receive photons scattered at various angles from the absorber's front surface.
3. The scattered intensity was too small to be observed.
4. For incident photon energies of about 70 eV, attenuation may be associated with processes which absorb energy within the foils.

(36)E

Trapeznikov, V. A., CALCULATION OF THE REABSORPTION FOR THE SHORTEST WAVELENGTH LINE OF AN X-RAY EMISSION SERIES. (In Russian.) Fiz. Metal. i Metallovedne 7, 294-295 (1959). Trans: Physics of Metals and Metallography 7 (2), 130-132 (1959).

1. The  $L\beta_2$  absorption spectrum in Mo was studied.
2. A bent crystal (quartz) spectrograph was used to study the 1 micron thick absorbers; 5 kV electrons at 3-4 ma caused the excitations.
3. The reabsorption accounting resulted in considerable changes in the form and position of the lines in the emission series.

Tsutsumi, K., et al, - See Review (R-17).

(37)E

Tsutsumi, K., X-RAY NON-DIAGRAM LINES  $K\beta'$  OF SOME COMPOUNDS OF THE IRON GROUP. J. Phys. Soc. Japan 14, 1696-1706 (1959).

1. The  $K\alpha_{3,4}$  of Fe and the  $K\beta'$  from  $Cr_2(SO_4)_3$  in  $H_2O$ ;  $Cr_2O_3$ ;  $MnO_2$ ;  $MnSO_4 \cdot 4H_2O$ ;  $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$ , and  $Fe_2O_3$  were studied.
2. Samples were excited by Ni-K and then by Cu-K radiation in a bent crystal (quartz) spectrograph; intensities were recorded photographically.
- 3a. Spectra are shown and results are tabulated.
- 3b. No difference could be found for the  $K\beta'$  line for energies higher or lower than  $K(Z) + L(Z+1)$ .
4. The  $K\beta'$  line is due to a single ionization and it can be derived from the difference of the exchange interactions of the states having different total spins ( $S+1/2$ ) and ( $S-1/2$ ) where  $S$  is the total spin of the incomplete 3d shell and 1/2 is that of the incomplete 3p shell in the final state.

(38)E

Vainshtein, E. E., B. I. Kotlyar and G. A. Shapiro, STUDY OF FINE X-RAY ABSORPTION SPECTRA OF IRON IN SOME ANTIFERROMAGNETIC SUBSTANCES AND FERRITES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 125, 55-58 (1959).

Trans: Sov. Phys. "Doklady" 4, 316-318 (1959).

1. The materials  $Fe_2O_3$ ;  $SrO \cdot 6Fe_2O_3$ ;  $MnO \cdot Fe_2O_3$ ;  $ZnO \cdot Fe_2O_3$ ;  $CoO \cdot Fe_2O_3$ ; and  $NiO \cdot Fe_2O_3$  were studied.
2. A Johann bent crystal (quartz) spectrograph was used and intensities were recorded photographically.
- 3a. The K absorption edge wavelength is independent of the magnetic state in the compounds studied.
- 3b. All spectra are shown.
4. "Tentative" conclusions concerning the chemical bonding in the compounds studied are reached.

(39)E

Vainshtein, E. E. and E. A. Zhurakovskii, NEW DATA ON THE X-RAY EMISSION SPECTRA OF TITANIUM IN CERTAIN HYDRIDES, CARBIDES, AND NITRIDES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 128, 695-697 (1959) Trans: Sov. Phys. "Doklady" 4, 1050-1052 (1959)

1. The  $K\beta_5$ ,  $K\alpha_1$ , and  $K\alpha_2$  groups were studied in stoichiometric TiC, TiN, and 1, 2, and 3% H in Ti and pure Ti.
2. A curved crystal (quartz) spectrograph with a dispersive power of 2.5 XU/mm was used; data were recorded photometrically at five cross-sections along the lines and averaged.
- 3a. All spectra are presented.
- 3b. The  $K\beta_5$  was displaced about 1 eV toward shorter wavelengths in the hydrides as compared with the pure metal although the shapes were very similar.

(40)E

Vainshtein, E. E. and E. A. Zhurakovskii, THE FINE STRUCTURE OF THE K ABSORPTION SPECTRA OF Ti-HYDRIDE, BORIDE, AND SILICIDE. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Otdel. Khim. Nauk 1959, 1493-1495. Annotation from Chem. Abs. 54, 6295c.

2. A crystal spectrometer was used.
3. As the specific number of boron and silicon atoms is increased, a tendency toward the formation of individual structural elements from the metalloid atoms appears and the bond between the atoms acquires a more covalent character.

(41)E

Vainshtein, E. E., E. A. Zhurakovskii and I. B. Staryi, ON SOME RESULTS OF X-RAY SPECTRAL INVESTIGATIONS OF THE PHYSICAL NATURE OF INTERSTITIAL PHASES. (In Russian.) Zhur. neorg. khim. 4, 245-246 (1959). Trans: Russian Journal of Inorganic Chemistry 4 (1), 104-105 (1959).

1. The K absorption of Titanium in TiN, Ti-C (9-24%C),  $TiB_2$  and 1.2 and 2% hydrogen Ti-hydrides was studied.
2. Crystal spectrometry coupled with photographic means was used to obtain the spectra.
- 3a. The longwave absorption line in the hydrides disappears when the H content is equal to or greater than 2%; this line indicates the

(41)E Cont'd.

- existence of vacancies in the 3d shell of Ti.
- 3b. Large differences were found in hydride bonding as compared with bonding of carbides and nitrides.
- 3c. The fine structure of the K edge of Ti in borides is more complex than for nitrides and carbides.

(42)E

Zhurakovskii, E. A. and E. E. Vainshtein, X-RAY K ABSORPTION SPECTRA OF VANADIUM IN HYDRIDES, NITRIDES, BORIDES, AND CARBIDES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 127, 534-537 (1959) Trans: Sov. Phys. "Doklady" 4, 826-828 (1960).

2. A Johann bent crystal spectrograph was used and intensities were photographically recorded.
- 3a. In going from oxide to nitride, the intensity of the longwave white absorption line changes, but its position does not.
- 3b. All spectra obtained are shown but are not interpreted.

(C-1)T

Asaad, W. N., RELATIVISTIC CALCULATION OF THE K-LL AUGER SPECTRUM. Proc. Roy. Soc. (London) A-249, 555-573 (1959).

1. A calculated K-LL Auger spectrum for Hg is presented.
2. Moller's treatment for the interaction of radiation with electrons was used in order to make the calculations.
- 3a. Relativistic effects increase the Auger transitions by about 84% and decrease the radiative transitions by about 75%.
- 3b. The K series fluorescence yield,  $\omega_K$ , was estimated to be 0.961 for Hg.
- 3c. Tables of transition probabilities for Hg are presented.

(C-2)E

Batterman, B. W., X-RAY MEASUREMENT OF THE DISTRIBUTION OF ELECTRONS IN IRON AND COPPER. Phys. Rev. Letters 2, 148 (1959).

- 1,2. The X-ray intensities for Fe (carbonyl) and Cu (smooth molded powder 0-60,000 PSI) were measured with Fe-K radiation.
3. The number of 3d electrons was the same as for the free atom in both Fe and Cu.

(C-3)T

Belding, E. F., THE 3d BAND STRUCTURE OF SOME TRANSITION ELEMENTS. Phil. Mag. (8) 4, (46) 1145-1149 (1959).

1. The 3d band structure for Cr, Fe, and Ni was calculated.
- 2a. A tight binding approximation was used, taking into account the interaction of first and second neighbors.
- 2b. A table of the overlap integrals used is given.
- 3a. The 3d band showed a broadening at the lower

energy limit for BCC Cr and Fe, but only a negligible effect for FCC-Ni.

- 3b. A density of states curve for Fe is presented.

(C-4)E

Bergvall, P., PRECISION MEASUREMENT OF  $K\alpha$  X-RAY LINES FROM RARE EARTH ELEMENTS. Arkiv Fysik 16, 57-68 (1959).

1. Elements of  $Z = 57-60$  and  $62-71$  were studied; La, Ce, Pr, and Nd were metals and the remainder of the elements were oxides.
2. A curved crystal (quartz) spectrometer equipped with a scintillation counter was used.
3. The  $K\alpha$  line wavelengths in XU are tabulated to six significant figures.

(C-5)T

de Carvalho, A. P., THE BAND STRUCTURE OF TELLURIUM. (In French.) Compt. Rend. (French Academy) 248, 778-781 (1959).

- 1,2,3. The secular Reitz equation was used to calculate the band structure.

(C-6)T

Elliott, R. J., and R. Loudon, ABSORPTION EDGE SPECTRUM OF DIAMOND. J. Chem. Phys. Solids 8, 382 (1959).

1. The effect of magnetic fields and excitons on the absorption edge in semiconductors was examined.
2. Simple spherical bands were assumed and spin effects were neglected.

(C-7)T

Faulkner, J. S., ELECTRON ENERGY BANDS OF ONE DIMENSIONAL RANDOM ALLOYS. Univ. Microfilms, L.C. Card #MIC 59-5891, 93 pp. (1959).

1. A model consisting of two different types of symmetric potential wells equally spaced in a "random" sequence with a fixed concentration was used.
2. The method of Korringa and a method in which electron scattering is characterized by a 2 by 2 matrix expressing traveling waves on one side in terms of those on the other side were both employed.
3. An attempt to predict density of states curves was made.

(C-8)E

Frey, W. R., R. E. Johnston and J. I. Hopkins, K SERIES FLUORESCENCE YIELDS ( $\omega_K$ ) FOR V, Mn, AND Ne. Phys. Rev. 113, 1057-1060 (1959).

2. A proportional counter was used to measure  $\omega_K$ ; counting gas was P-10 and the counter was Al.
- 3a. The Auger electron spectra are presented.

(C-8)E Cont'd.

3b.	Element	$\psi_k$
	V	$0.304 \pm 0.013$
	Mn	$0.308 \pm 0.015$
	Ne	$0.043 \pm 0.004$

3c. These data are compared with earlier results.

(C-9)E

Fujiki, Y., VACUUM DEPOSITION OF ALLOYS  
J. Phys. Soc. Japan 14, 913-917 (1959).

1. The formation of alloy phases by successive deposition of constituent metal vapors in vacuum was studied by electron diffraction for the alloys of Au-Pb, Bi-Pb, Cu-Sn, Ag-Sn, and Cd-Sn.
2. The total amount of metal used was 10 mg, and the evaporation rate was 25 mg/min.; the pressure was  $2 \times 10^{-5}$  mm Hg.
3. The temperature of the surface layer of the primary deposit is elevated by depositing the second metal, and this rise contributes to the formation of true alloy phases; this is due to the latent heat of condensation of the metal deposited on the substrate.
4. Metal pairs having large heats of condensation may form alloys easily.

(C-10)T

Greiner, H. and E. Schaffer, ASTIGMATISM OF THE CONCAVE GRATING WITH SPHERICAL OR TOROIDAL SURFACES. (In German.)  
Optik 16, 288-303 (1959).

1. The toroidal and spherical gratings are compared with reference to the incident light density (spectrograph) of the radiant flux leaving the exit slit (spectrometer).
3. A procedure is given so that the ratio of the radii of curvature for the toroidal grating and the incident angle can be found so that departure from a stigmatic image is a minimum.
4. The density of incident light or radiant flux depends on the length of entrance and exit slits.

(C-11)E

Hass, G. and R. Tousey, REFLECTING COATINGS FOR THE EXTREME ULTRAVIOLET.  
J. Opt. Soc. Am. 49, 593-602 (1959).

1. Conditions for preparing evaporated films of Al for use on the grating are summarized and the effect of thin overcoatings on the efficiency of ruled gratings is discussed.
- 3a. Data on Pt, ZnS, and  $Al_2O_3$  for use as overcoatings below 1200A are presented.
- 3b. From 0-400A, extrapolation of the curves of reflectance vs. wavelength given shows that Pt has about 15-20% reflectivity while Al has about 5-10% reflectivity.

(C-12)T

Henke, Burton L. and Jack C. Miller, ULTRASOFT X-RAY INTERACTION COEFFICIENTS. REPORT No. 3 ON ULTRASOFT X-RAY PHYSICS.  
Office of Technical Services PB144965, 84 pp. (1959).

1. Interaction coefficients for ultrasoft X-radiation were derived by semi-empirical methods.
2. Semi-empirical relations, based on quantum-mechanical theory with certain simplifying assumptions applicable in the soft X-ray region (10-100A) were determined by interpolation of available data.
3. Results obtained for photoelectric absorption coefficients, atomic scattering factors, ultrasoft X-ray scattering, and ultrasoft X-ray reflection are presented graphically and in tabular form.

(C-13)T

Kanamori, J., SUPEREXCHANGE INTERACTION AND SYMMETRY PROPERTIES OF ELECTRON ORBITALS.  
J. Chem. Phys. Solids 10, 87-98 (1959).

1. In some cases, the sign of the superexchange interaction is determined by symmetry relations; cases in which the cation is subject to an octahedral cubic field and in which lines connecting interacting cations to the intervening anion make an angle of 90 or 180° are discussed.
3. Examples for perovskite, NaCl,  $TiH_2$ , and some anhydrous chlorides are given.

(C-14)T

Kelley, R. L., VACUUM ULTRAVIOLET EMISSION LINES BELOW 2000A.  
U.S. At. Energy Comm. UCRL-5612, 520 pp. (1959)

1. Lines below 2000A are tabulated.
2. Data were taken from 811 references.

(C-15)T

Kleinman, L. and J. C. Phillips, SELF-CONSISTENT CALCULATIONS FOR DIAMOND.  
Phys. Rev. 116, 880-884 (1959).

1. Approximate self-consistent potentials with exchange included are obtained.
2. The Slater free electron approximation was used.
- 3a. Inclusion of the momentum dependence of the exchange potential alters the valence band width.
- 3b. Tables of calculated energies are presented.

(C-16)R

Kurylenko, C., TECHNIQUE FOR OBTAINING ABSORPTION AND EMISSION SPECTRA BY MEANS OF X-RAYS. (In French.)  
Cahiers de Physique 13, No. 106, 237-256 (1959).

1. A general description of the methods of crystal spectrometry and photographic photometry including historical background, general solid state and X-ray excitation theory and photoelectric theory is given. A few spectra, notably W and Ag, are presented.



(C-17)T

Lohmann, A., CONTRAST TRANSFER IN THE GRATING SPECTROGRAPH.

Optica Acta (Paris) 6, 175-185 (1959).

1. Calculations are based on the theory of contrast transfer for optical image formation.
2. The spectral distribution of the light falling into the entrance slit is calculated from the measured intensity by Fourier methods.
3. General formulae for the intensity distribution in a grating spectrograph with various types of grating errors, aperture diffraction, aberrations, and amplitude filters are given. Note: A comprehensive bibliography on contrast transfer is given.

(C-18)A

Namioka, T., THEORY OF THE CONCAVE GRATINGS I, II, III.

J. Opt. Soc. Am. 49, I:446-459, II:460-465, III:951-960, (1959).

- 1,2. The concave grating theory is examined in terms of geometrical optics and astigmatism, and other aberrations are treated with respect to the finite length of slit illumination, grating size, and deviations of optical components from the Rowland plane, but still on the Rowland cylinder.
- 3a. The aberrations in an off-plane Eagle mounting can be corrected by rotating the slit perpendicular to the optical axis.
- 3b. Tables and graphs for the optimum grating size of a 21-foot radius grating with 30,000 lines/inch and for a 1-meter grating with 15,000 lines/inch are given.

(C-19)A

Namioka, T., DESIGN OF A HIGH RESOLUTION MONOCHROMATOR FOR THE VACUUM ULTRAVIOLET.

J. Opt. Soc. Am. 49, 961-965 (1959).

1. The off-plane Eagle mounting is chosen as that most suitable for the vacuum ultraviolet.
- 3a. The resolving power of the grating with this mounting is calculated numerically for a 3-meter grating with 30,000 lines/inch, 0-5800 Å (1st order) and a distance of the entrance slit from the Rowland plane of 6 cm.
- 3b. A tentative instrumental design is presented.

(C-20)E

Nordling, C., K AND L ENERGY LEVELS IN SOME FOURTH AND FIFTH PERIOD ELEMENTS.

Arkiv. Fysik 15, 397-429 (1959).

1. The K and L binding energies in Cu, Zn, Ga, Ge, and Se, and the L binding energy in elements from Rh through Te were studied by the photo-electron method.
2. The kinetic energy of the photo-electrons was determined with an iron-free, double focusing  $\beta$  spectrometer equipped with a G-M counter; a schematic diagram of the apparatus is given.
3. All results are tabulated and all photo

spectra are presented; a modified Mosely diagram for the K binding energies of the fourth period elements is also given.

(C-21)E

Nordling, C. and S. Hagstrom, ELECTRON BINDING ENERGIES IN URANIUM.

Arkiv. Fysik 15, 431-443 (1959).

1. The  $L_3$ ,  $M_2$ ,  $M_5$ , and  $N_1$ ,  $N_5$  level energies were measured in uranium by the photo-electron method.
- 2a. A magnetic spectrometer equipped with a G-M counter was used to observe the evaporated (onto an Al backing) U targets; no value for the pressure of the system was given.
- 2b. The  $K\alpha_1$  lines of Ag, Pd, Ge, and Cu were used to excite the desired photo-lines.
3. All data are tabulated and L and M photo-emission spectra are presented.

(C-22)

Posener, D. W., THE SHAPE OF SPECTRAL LINES - A TABLE OF THE VOIGT PROFILE

$$\frac{a}{\pi} \int_{-\infty}^{+\infty} e^{-y^2} dy (1/a^2 + [v - y]^2)$$

Australian J. Phys. 12, 184-196 (1959).

1. The line shape which results when any spectral line is broadened simultaneously by Gaussian and Lorentzian effects is computed.
2. The equation for this effect is solved with a digital computer.
3. Tables of results for values of the titular function are presented.

(C-23)T

Robins, D. A., AN INTERPRETATION OF SOME OF THE PROPERTIES OF THE TRANSITION METALS AND THEIR ALLOYS.

J. Less Common Metals 1, 396-411 (1959).

1. Many of the properties of the transition metals can be interpreted in terms of a relationship between the coordination number and the number of bonding electrons per atom.
- 4a. The electron resonance bond strength is a maximum when the number of bonding electrons per atom is equal to half the coordination number; "effective" coordination numbers must be invoked to support this view.
- 4b. The stability of this arrangement dictates the alloying behavior and the crystal structure of the transition metal in question.

(C-24)T

Suoninen, E. J., INFLUENCE OF INDIRECT EXCITATION ON THE INTENSITY OF A FLUORESCENT X-RAY LINE IN TWO PARTICULAR CASES. (In English.) Ann. Acad. Sci. Fennicae, Ser. A VI #15, 12 pp. (1959).

- 1,3. An expression for the intensity of a fluorescent line in terms of true and total absorption

(C-24)T Cont'd.

coefficients in which the primary beam is assumed to be able to excite a line  $\lambda_A$  of element A and  $\lambda_B$  of element B, is given.

(C-25)T

Trost, W. R., ORBITAL CONSTRUCTIONS AND ELECTRON POPULATIONS IN TRANSITION ELEMENTS.  
Can. J. Chem. 37, 460-474 (1959).

1. Orbital constructions and electron populations for the bands in transition metals are presented.
- 3a. It is possible to predict the crystal structure of the elements if there is a uniform density of states in delocalized bands among nearest neighbors.
- 3b. Numerical values for electron populations in the s, p, d, and hybrid bands including their bonding, antibonding, and non-bonding levels are presented.
- 3c. Density of states curves are given for 1, 5, 9, and 12 electron atoms.  
Note: Excellent drawings of hybrid bonds are included.

(C-26)T

Waldron, R. D., INTENSITY AND DAMPING DEPENDENCE OF VARIOUS PARAMETERS DESCRIBING SPECTRAL LINE SHAPES.  
J. Opt. Soc. Am. 49, 609-618 (1959).

1. Expressions for several properties of a damped harmonic oscillator system are given.
3. Equations for the displacement maxima of these properties as a function of line width and strength are also given.

(C-27)E

Walker, W. C., O. P. Rustgi and G. L. Weissler, OPTICAL AND PHOTOELECTRIC PROPERTIES OF THIN METALLIC FILMS IN THE VACUUM ULTRAVIOLET.  
J. Opt. Soc. Am. 49, 471-475 (1959).

1. Evaporated films of Al, Sn, In, Bi, Au, Ag, and Cd were studied in order to correlate optical transmission, reflection, and photoemission between 411 and 2072A.
- 3a. The frequency at which the reflection-transmission transition occurs is compared to that predicted by the Bohm-Pines theory.
- 3b. New absorption transitions were observed and related to X-ray absorption edges.
- 3c. Results for each film studied are plotted.

(C-28)T

Watson, R. E., IRON SERIES HARTREE-FOCK CALCULATIONS.  
M.I.T. Solid State and Molecular Theory Group, Tech. Rept. 12, 258 pp. (6-15-1959).

1. It was assumed that there is a common one-electron radial function for all electrons in any given shell and that all ion states have a common one-electron radial function for each shell.
2. Slater two-electron integrals were used to find the interaction between the ion and the

crystalline field.

3. Equations and data for ions in cubic fields are tabulated.

(C-29)E

Weiss, R. J. and J. J. DeMarco, X-RAY MEASUREMENT OF THE DISTRIBUTIONS OF ELECTRONS IN IRON AND COPPER.  
Phys. Rev. Letters 2, 47 (1959).

- 1,2. The (110) peak of iron relative to Al for Fe-K $\alpha$  and Mo-K $\alpha$  radiation was measured.
3. Results indicate that iron has only  $2.5 \pm 1.5$  electrons of d type.

(C-30)E

Weiss, R. J. and A. J. Freeman, X-RAY AND NEUTRON SCATTERING FROM ELECTRONS IN A CRYSTALLINE FIELD AND THE DETERMINATION OF OUTER ELECTRON CONFIGURATIONS IN IRON AND NICKEL.  
J. Chem. Phys. Solids 10, 147-161 (1959).

1. The effect of non-spherical charge distributions on X-ray and neutron scattering factors is calculated for d and f electrons in hexagonal, cubic, and tetrahedral crystalline fields.
- 3a. Polarized neutron data show that double and triply degenerate orbitals are equally populated in iron.
- 3b. In nickel, the holes are 75% in triply degenerate orbitals and 25% in doubly degenerate orbitals.
- 4a. In BCC iron, the spin density arises from 2.2 3d atom-like electrons in one spin direction.
- 4b. In nickel, the spin density is from 5.0 ed atom-like electrons with spin up and 4.3 with spin down.

1960

(1)E

Averbukh, E. D., USE OF X-RAY SPECTROSCOPIC DATA IN THE STUDY OF THE ENERGETIC STRUCTURE OF SOLID BODIES. (In Russian.)  
Vestnik Leningrad. Univ. 15, #16; Ser. Fiz. i Khim. (3), 36-41 (1960).  
Annotation from Chem. Abs. 55, 3188d.

1. Polarization effects in the initial and final states of an ionic crystal undergoing X-ray emission were studied.
- 3a. These polarizations are important in determining the cross transitions belonging to different ions.
- 3b. The energy structure of KCl and NaCl is explained by this theory.

(2)E

Axelrod, N. N. and M. P. Givens, OPTICAL MEASUREMENT OF THE PLASMA FREQUENCY AND THE M<sub>2,3</sub> BAND OF CHROMIUM.  
Phys. Rev. 120, 1205-1207 (1960).

- 1,2. A grating equipped vacuum spectrograph was used to study vacuum deposited Cr at a pressure of  $5 \times 10^{-5}$  mm Hg; intensities were recorded photographically.

(2)E Cont'd.

- 3a. The Cr films became transparent at 500Å (24.8 eV).  
3b. A soft X-ray absorption plot for Cr ( $\mu\nu s\lambda$ ) is given for the 200-800Å region, but no  $M_{2,3}$  band is shown.

(3)T

Barinskii, R. L. and E. G. Nadzhakov, CALCULATION OF THE CHARGE OF ATOMS IN MOLECULES FROM X-RAY K ABSORPTION SPECTRA. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 407-414 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

1. Using data for Cl, Br, Ge, Zn, Fe, and Cr in halides and oxides as measured by various other workers, a series of equations are derived describing the absorption edge from line width data, charge of the absorber and effective quantum number.  
3. The secondary absorption maximum of Br, Zn, Cl, and Ge in certain compounds is explained by hole formation in the K shell.

(4)E

Bergvall, P. and S. Hagstrom, ATOMIC LEVEL ENERGIES IN RARE EARTH ELEMENTS. Arkiv Fysik 17, 61-79 (1960).

1. The  $L_1$ ,  $L_2$ ,  $L_3$  level energies in the oxides of stable lanthanides were measured.  
2. Photoelectric spectrometry was used.  
3. All results are tabulated.

(5)T

Borisov, M. D. and V. V. Nemoshkalenko, ENERGY DETERMINATION OF X-RAY PHOTONS AND THE ENERGIES OF ELECTRONIC LEVELS IN ATOMS. (In Russian.) Izvest. Akad. Nauk. S.S.S.R. Ser. Fiz. 24, 393-396 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

1. All previous tabular data made with spectrometers using calcite crystals is corrected due to an improved value determination of the calcite lattice.  
2,3. Corrected energies are calculated by means of the following equation:  
 $E \text{ (Rydbergs)} = 5.9587650 - \log \lambda \text{ (XU)}$

(6)E

Borisov, M. D., V. V. Nemoshkalenko and A. M. Fefer, INFLUENCE OF THE NICKEL CONCENTRATION ON THE STRUCTURE OF THE ENERGY SPECTRUM OF ELECTRONS IN IRON-CHROMIUM ALLOYS. (In Russian.) Izvest. Akad. Nauk. S.S.S.R. Ser. Fiz. 24, 443-446 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In process.)

1. The  $K\beta_5$ ,  $K\beta$ , and  $K\beta^{1,1}$  of Cr, Fe and 40 w/o Fe-Cr-Ni alloys containing 0, 2, 5, 7, and 10 w/o Ni were studied at 1000°C.  
2. A crystal spectrometer was used.  
3. A curve showing the 3d band in Fe-Cr-Ni

alloys is presented.

(7)T

Borisov, M. D. and V. A. Batiev, FINE STRUCTURE OF THE FUNDAMENTAL K EDGE OF THE X-RAY ABSORPTION SPECTRA OF IRON GROUP ELEMENTS. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 441-442 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

- 1,3a. Long wave structure gradually decreases in the order Ti, V, Cr, Fe, Co, Ni, and Cu; this corresponds to the unfilled portion of the d band.  
3b. The horizontal portion of the structure is ascribed to 4sp photoelectric transitions.  
4. The fundamental K edge is a superposition of two absorption edges.

(8)E

Borovskii, I. B. and V. V. Schmidt, THE FINE STRUCTURE OF X-RAY ABSORPTION SPECTRA AND CHARACTERISTIC LOSSES OF ELECTRON ENERGY. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 428-432 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

1. K absorption spectral measurements were made on a foil of iron heated by self-resistance over a temperature range of 20-950°C.  
2. A crystal spectrometer was used.  
3. Changes in the fine structure occurring during the  $\alpha \rightarrow \gamma$  phase change are listed.

(9)E

Bril, M. N., AN INVESTIGATION ON THE TEMPERATURE DEPENDENCE OF THE FINE STRUCTURE OF THE FUNDAMENTAL REGION OF THE X-RAY ABSORPTION SPECTRA OF TITANIUM IN BARIUM TITANATES NEAR THE CURIE POINT OF BaTiO<sub>3</sub>. (In Russian.) Doklady Akad. Nauk S.S.S.R. 131, 535-537 (1960).  
Trans: Sov. Phys. "Doklady" 5, 310-312 (1960).

2. A bent crystal (quartz) spectrograph was used; intensities were recorded photographically with exposure times of 3-5 hours.  
3a. The diffuseness of the fine structure increases in a monotonic manner up to the Curie point; above this point the fine structure of Ti in a compound is much lower than in a ferroelectric.  
3b. In the nonferroelectric Ba-tetratitanate, no temperature dependence is observed.  
3c. Spectra vs. temperature curves for BaTiO<sub>3</sub> and BaO·4TiO<sub>2</sub> are given.

(10)E

Crisp, R. S., SOFT X-RAY EMISSION FROM POTASSIUM METAL IN THE 40-1000Å RANGE. Phil. Mag. (8) 5, 1161-1169 (1960).

- 1,2. A grazing incidence grating vacuum spectrometer capable of being evacuated to a pressure of  $1 \times 10^{-6}$  mm Hg was used to study evaporated K metal; intensities were measured by a Be-Cu photomultiplier.



(10)E Cont'd.

- 3a. Seven lines and bands were found, of which two are deduced to be the L and M valence band spectra, 3 are diagram lines and 2 (very broad) are not identified; all spectra are shown, and the data pertinent to the observed features are tabulated.
- 3b. A density of states curve is deduced from the potassium M emission band and an energy level diagram is constructed based on the observed data.

(11)E

Crisp, R. S. and S. E. Williams, THE K-EMISSION SPECTRUM OF METALLIC LITHIUM. Phil. Mag. (8) 5, 525-527 (1960).

1. The third order L spectrum was studied with a "virtually uncontaminated target surface."
2. A spectrometer having a grating with 576 lines/mm was employed which when used with a 40 $\mu$  slit width gave a resolution of 0.07 eV.
- 3a. An actual spectrum which shows a high energy edge and an anisotropic Fermi surface is presented; the edge width is 0.30 eV.
- 3b. Edge widths for Na-L and potassium M were 0.21 eV and 0.19 eV respectively.

(12)E

Crisp, R. S. and S. E. Williams, THE SOFT X-RAY SPECTRA OF LITHIUM, MAGNESIUM AND ALUMINUM AND THEIR ALLOYS. Phil. Mag. (8) 5, 1205-1216 (1960).

1. Pure Li, Mg, and Al and solid Mg-Li specimens containing 15, 40, and 70 a/o Li respectively were studied.
- 2a. A glass grating, grazing incidence, spectrometer capable of being evacuated to  $1-2 \times 10^{-6}$  mm Hg was used. Specimens were cooled to (-100°C) by a liquid air finger; this virtually excluded carbonaceous contamination.
- 2b. Intensities were obtained by a Be-Cu photo-multiplier; a tungsten carbide scraper was used to clean the targets which were irradiated at 4 kV and 8-11 ma target current.
- 3a. Electron transfer from Mg was observed in the alloys.
- 3b. The Mg band contracted and the Li band extended on the low energy side.
- 3c. Li deposited on Al yields a K spectrum having no metal edge.
- 3d. Spectra of all substances studied, and a "time-contamination" curve for the targets are shown.
- 4a. The changes in the K and L level screening compensate almost exactly for the electron transfer effect.
- 4b. For Li deposited on Al, the first zone is full and there is no zone overlap.

(13)E

Curry, C. and D. J. McNeill, SOFT X-RAY EMISSION SPECTRA OF SOME TRANSITION AND NOBLE METALS. Proc. Phys. Soc. (London) 76, 791-793 (1960).

1. Al and the  $M_{2,3}$  of Cu and Ni and the  $N_{2,3}$  of Rh, Pd, and Ag were studied.
2. A 1-meter grating with 1152 lines/mm was used at a grazing angle of  $5 \frac{3}{4}^\circ$  to study targets

which were scraped in a vacuum of  $5 \times 10^{-6}$  mm Hg; intensities were recorded on Ilford Q-1 plates with exposure times of 2-6 hours.

3a. Skinner's Cu- $M_{2,3}$  band shape was obtained.

3b. 

Element	$N_{2,3}$ bandwidth (eV $\pm$ 0.3)
Rh	1.3
Pd	1.3
Ag	2.1

(14)T

Deodhar, G. B. and S. T. H. Abidi, NEW RELATIONS IN THE X-RAY K AND L SATELLITES. Naturwissenschaften 47, 319 (1960).

1. Empirical relations are obtained for both the high and low frequency satellites for X-ray emission lines.
- 3a. The pertinent relationships for  $Z = 11-53$  are listed.
- 3b. The high frequency K satellites arise from the X-ray term difference for multiply ionized atoms.
- 3c. L shells are multiply ionized in the final state by the radiationless transition  $k \rightarrow L_1$ .

(15)E

Ganeev, A. S. and I. M. Izrailev, INTERACTION CROSS SECTIONS OF SOFT X-RAYS WITH LITHIUM. (In Russian.) Zhur. Tekh. Fiz. 30, 1085-1086 (1960). Trans: Soviet Phys. "Tech. Phys." 5, 1016-1017 (1960).

1. The values of  $\mu/p$  for Li were measured in the region of X-ray energies 5.5 to 20 keV.
2. A quartz crystal spectrometer was used to obtain data from a Li specimen of 0.553 g/cm<sup>2</sup> thickness containing small amounts of some sixteen known impurities.
3. Data are presented graphically and a comparison with Slater's theoretical data is made.

(16)T

Gorak, Z., ORIGIN OF SOME SATELLITES IN X-RAY SPECTRA. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 422-423 (1960). Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

1. Satellites of the  $K\alpha$  of Ne and the  $K\alpha$  of  $Fe^{+++}$  were studied.
- 3a. Lines  $K\alpha'$  and  $K\alpha''$  of Ne are caused by the interaction of vacancies in the 1s and 2p shells.
- 3b. The  $K\beta'$  line of  $Fe^{+++}$  is caused by the interaction of a 3p vacancy with the partially filled 3d<sup>5</sup> shell.

(17)A

Holliday, J. E., A SOFT X-RAY SPECTROMETER USING A FLOW PROPORTIONAL COUNTER.  
Rev. Sci. Instr. 31, 891-895 (1960).

1. The K emission spectra of C and Be and the  $M_{4,5}$  emission spectra of Mo and Nb were studied.
2. A blazed grating spectrometer equipped with a P-10 flow proportional counter having a 1000A window which transmits 17% of incident radiation at 200A was used; the spectrometer operates in the range 30-200A and can be evacuated to  $10^{-7}$  mm Hg.
3. All spectra are presented.

(13)A

Jacob, L., R. Noble and H. Yee, PHOTOMULTIPLIER SOFT X-RAY SPECTROMETER.  
J. Sci. Instr. 37, 460-462 (1960).

1. A new soft X-ray spectrometer at the University of Liverpool is described.
- 2a. The spectrometer has a 15 stage Be-Cu photomultiplier mounted on a radial arm rotating about the Rowland circle, a 30,000 lines/inch grating is used and the slit width is 0.004 in. with a resolution of 1A.
- 2b. The pulses are integrated by using a direct current amplifier to amplify the average current from the multiplier.
- 3a. The spectrometer, grating mounting and amplifier circuits are diagramed.
- 3b. Preliminary emission band spectra of Al, Mg, Na and Li are presented.

(19)E

Johansson, P., AN EXPERIMENTAL INVESTIGATION OF X-RAY EXCITATION STATES IN SOLIDS.  
Arkiv. Fysik 18 (4), 289-303 (1960).

1. The  $K\alpha_1$  line of metallic Cr and of  $Cr_2O_3$  is recorded at only a few volts above the excitation potential.
2. A bent crystal (topaz) spectrometer evacuated to  $10^{-6}$  mm Hg was used; intensities were determined with a commercial G-M counter.
- 3a. A small (0.1 eV) wavelength shift is found by using this "low" excitation voltage.
4. Three major conclusions are reached:  
(a) The position in the spectrum of an X-ray line is dependent upon the voltage for excitation energies slightly above the threshold value; (b) The energy shift between threshold curves and ordinary curves is small; (c) The emission energy is lower for the threshold line than for the ordinary line.

(20)E

Karal'nik, S. M., I. G. Nikolaeva and N. N. Mefedov, HIGH TEMPERATURE X-RAY SPECTRAL INVESTIGATION IN INVAR ALLOYS. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 473-475 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In process.)

1. The displacement of the iron K absorption edge was measured in Fe-Pt alloys containing 25, 48, 56, and 75 w/o Pt; the 25, 48, and

56 w/o Pt alloys were also measured between 70 and 930°C; an alloy containing Fe-34 w/o Ni was also investigated.

2. A crystal spectrometer was used.
3. The K edge in the 48% Pt alloy was displaced to longer wavelengths with rising temperature while the reverse was true in the 56% Pt alloy.

(21)E

Kern, B., THE Si K $\beta$  BAND FROM X-RAY EMISSION SPECTRA OF ELEMENTARY SILICON, CARBORUNDUM AND QUARTZ. (In German.)  
Z. Physik 159, 178-193 (1960).

- 1,2. A bent crystal vacuum spectrograph with a dispersive power of 0.498 mm/eV was used to study the SiK $\beta$  emission bands of Si, SiC, and SiO<sub>2</sub>; intensities were recorded photographically.
- 3a. All spectra and a table giving the energy values of the structural features are presented.
- 3b. Comparison of the results with results for diamond indicate that these are valence band spectra and that they are only slightly influenced by unusual perturbed states.
4. The bonding is essentially covalent in all cases.

(22)E

Korsunskii, M. I. and Ya. E. Genkin, FLUORESCENCE SPECTRA OF NIOBIUM IN THE COMPOUNDS Nb $\beta_2$ , NbC, NbN, AND IN PURE Nb. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 461-464 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

2. A curved crystal (mica) spectrograph was used to study L $\beta_2$  and L $\gamma_1$  lines, and the spectra were photographically recorded.
- 3a. Satellite lines of Nb are changed in the compounds due to L<sub>2</sub>  $\rightarrow$  N<sub>4</sub> and L<sub>3</sub>  $\rightarrow$  N<sub>5</sub> transitions.
- 3b. The density of d states is discussed.

(23)T

Korsunskii, M. I. and Ya. E. Genkin, INTENSITY RATIO OF THE L $\beta_2$ , L $\beta_{15}$ , and L $\gamma_1$  LINES IN THE L SERIES OF SUBSTANCES WITH AN UNFILLED N SHELL. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 465-469 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

- 1,2. The number of transitions for L $\alpha_1$ , L $\alpha_2$ , L $\beta_1$ , L $\beta_2$ , L $\beta_{15}$ , and L $\gamma_1$  lines are computed on the basis of the degree of filling of the N shell.
3. The density of d<sub>3/2</sub> and d<sub>5/2</sub> states in Nb, Mo, Rh, Pd, and Ag is calculated.

(24)T

Kurylenko, C., ISOLATED BREAKS IN THE X-RAY K DISCONTINUITY OF COPPER. (In French.)  
Cahiers de Physique 14 No. 113, 25-28 (1960).

(24)T Cont'd.

- 1,2. T. Hayashi's theory of absorption spectra is examined and Veldkamp's mass absorption coefficient measurements on Cu are explained on this basis.
- 3a. The isolated breaks (fine structure) are asymmetric with respect to the energy positions  $E(200)$ ,  $E(220)$ .
- 3b. The respective mass absorption coefficient symmetry variations indicate that perturbed energy states predominate over non-perturbed states.
- 3c. Detailed diagrams of the fine structure and the  $\mu/\rho$  variation vs. wavelength are given.

(25)T

Kurylenko, C., FINE STRUCTURE IN THE NEIGHBORHOOD OF THE K X-RAY DISCONTINUITY IN ZINC. *Cahiers de Physique* 14, No. 115, 119-123 (1960). (In French.)

1. The probability of electron transfer between perturbed and non-perturbed energy zones is examined.
2. The theories of Brillouin, Bethe and Hayashi concerning the variation of the mass absorption coefficient,  $\mu/\rho = P(E)$  where  $P(E)$  is the electron transport probability for perturbed and non-perturbed energy zones are used.
3. The probability vs. the actual  $\mu/\rho$  curve is plotted, and perturbed and non-perturbed energy contours in Zn are shown.

(26)E

Liefeld, R. J., L SERIES X-RAY EMISSION AND ABSORPTION SPECTRA IN ZIRCONIUM. Univ. Microfilms LC card #MIC 60-1197, 99 pp. (1960). Diss. Abs. 20, 4147 (1960).

1. The  $L\beta_2$  and  $L\gamma$  lines of Zr were studied.
2. A double crystal (quartz) spectrometer was used in the (1,+1) position at a pressure of  $4 \times 10^{-8}$  mm Hg.
3. A density of states curve with a fairly steep high frequency edge, with no evidence of the double peaked structure predicted for d-type states in first period transition elements, is proposed.

(27)E

Lucasson, A., STUDY OF Zn, Ga, Ge, and Cu ALLOYS BY X-RAY SPECTROGRAPHY. (In French.) *Annales de Physique* (13) 5, 509-565 (1960).

1. Both the L absorption and emission spectra in solid Zn, Ga, Ge, and the  $L_3$  edge of Cu in alloys of Cu-Ni, Cu-Zn, and Cu-Al were investigated.
2. A crystal spectrometer was used.
- 3a. Spectra and tabular results are presented.
- 3b. The measured  $L_2$  edge widths of Zn and Ge and the  $L\alpha + L\beta$  line widths gave the width of the third band in Zn and Ge.
- 3c. The Fermi level shift was obtained from the  $L_3$  edge shift in the Cu alloys.

(28)E

Lukirskii, A. P. and Yu. A. Omel'chenko, USE OF THE PHENOMENON OF "TOTAL EXTERNAL REFLECTION" FOR FILTERING THE CONTINUOUS SPECTRUM IN THE ULTRA-SOFT X-RAY REGION. (In Russian.) *Optika i Spektrosk* 8 (4), 563-568 (1960). Trans: *Optics and Spectroscopy* 8, 297-299 (1960).

1. The short wavelength component of the W continuum was filtered by means of Be or quartz reflectors at various angles.
2. A 600 lines/mm grating was used at a grazing angle of  $5.5^\circ$  in a vacuum spectrometer to study the radiation obtained; the vacuum was  $1 \times 10^{-6}$  mm Hg.
3. The W continuum (filtered and unfiltered radiation) and a table of the relative continuum intensities in the 100-150A region are presented.
4. This filtered radiation may be used as the source in the study of soft X-ray absorption spectra.

(29)A

Lukirskii, A. P., M. A. Rumsh and L. A. Smirnov, X-RAY MONOCHROMATOR FOR ULTRASOFT RADIATION WITH THE RECORDING OF THE ABSOLUTE NUMBER OF QUANTA. (In Russian.) *Optika i Spektroskopiya* 2, 505-508 (1960). Trans: *Optics and Spectroscopy* (U.S.S.R.) 2, (4), 262-265 (1960).

1. A 15,000 lines per inch vacuum X-ray monochromator for the spectral region 15-120A is described; the grating is one meter radius and the grazing angle is  $2.5^\circ$ .
- 2a. The K lines of F, O, C, B and Be are excited and this K radiation is used to excite the desired spectra; the pressure in the X-ray tube is  $5 \times 10^{-7}$  mm Hg.
- 2b. A methane quenched argon "Geiger" counter is used to obtain intensity data; a photomultiplier can also be used.
- 3a. Construction details and diagrams are presented.
- 3b. The characteristic K spectra of F, O, C, B, and Be are given.

(30)E

Lukirskii, A. P., M. A. Rumsh, and I. A. Karpovich, MEASUREMENT OF THE PHOTOELECTRIC YIELD OF THE EXTERNAL PHOTOEFFECT UNDER THE ACTION OF X-RAYS IN THE WAVELENGTH RANGE 1.54-13.3A. (In Russian.) *Optika i Spektroskopiya* 2, 653-657 (1960). Trans: *Optics and Spectroscopy* (U.S.S.R.) 2, 343-346 (1960).

- 1,2. An Allen Be-Cu photomultiplier was used to investigate the photoelectric yields of Ti, W, Pt, NaBr, SrF<sub>2</sub>, and CsI.
- 3a. A complete account of the operating characteristics for the photomultiplier is given for this spectral region.
- 3b. A table of photoelectric yields for the substances studied is given; the specimens were excited by characteristic X-rays of various elements.



(30)E Cont'd.

- 3c. The photoelectric yield rose with increasing wavelength.
4. The authors feel that this rise is due to the decreased penetration of the X-rays into the photocathode.

(31)E

Lukirskii, A. P., M. A. Rumsh and L. A. Smirnov, MEASUREMENT OF THE PHOTOELECTRIC YIELD FOR ULTRASOFT X-RADIATION. (In Russian.) *Optika i Spektroskopiya* 2, 511-513 (1960). Trans: *Optics and Spectroscopy (U.S.S.R.)* 2 (4), 265-267 (1960).

- 1,3. Values of the photoelectric yield on a percentage basis are given for Be, Ni, W, LiF, NaF, CaF<sub>2</sub>, SrF<sub>2</sub>, and NaCl excited by the K line of U, C, B, and Be, respectively.
- 2a. Using the apparatus described in Ref. #29, 1960, a Be-Cu photomultiplier was used to count small numbers of photoelectrons and a Geiger counter was used for absolute counting of quanta.
- 2b. The electrical apparatus details are given and it is shown that, in general, the number of registered impulses equals the number of photoelectrons if the probability of the appearance of two electrons as a result of the action of a single quantum is neglected.

(32)E

Mande, C, CONTRIBUTION TO THE STUDY OF GOLD AND PALLADIUM AND OF THEIR ALLOYS BY X-RAY SPECTROGRAPHY. (In French.) *Ann. phys.* 5, 1559-1614 (1960).

1. The L and M absorption spectra of pure Au, the K and L absorption spectra of pure Pd, the L absorption spectra of Au and the K absorption spectra of Pd in Au-Pd alloys and the L $\beta_2$  of Pd and the L $\beta_5$  Au emission lines were studied.
- 2a. A curved crystal (quartz) spectrograph was used. Intensities were recorded photographically, the spectra being obtained by means of microphotometry.
- 2b. For absorption specimens, Sandstrom's criterion for optimum absorber thickness was used.
- 3a. All spectra are given and the data are also tabulated.
- 3b. A density of states curve for pure Au, and Pd, based on the data, is presented.
- 3c. The changes in the absorption and emission spectra occurring on alloying are presented.

(33)E

Men'shikov, A. Z. and S. A. Nemnonov, X-RAY ABSORPTION SPECTRA IN COMPOUNDS WITH A NICKEL-ARSENIDE STRUCTURE. (In Russian.) *Fiz. Metal. i Metallovedne* 10, 390-396 (1960). Trans: *Physics of Metals and Metallography* 10 (3), 74-79 (1960).

1. The K absorption spectrum for Cr was studied

in the compounds CrS, CrSe, CrTe, and CrSb.

2. A quartz crystal spectrometer was used to study powdered specimens of the compounds; intensities were recorded photographically.
3. All spectra are presented for comparison with the spectrum of pure Cr; many differences are apparent.
- 4a. The d electrons of transition metals participate only weakly in the chemical bond in NiAs types.
- 4b. For the substances studied a p<sup>3</sup> or sp<sup>2</sup> electron configuration is most likely.

(34)E

Nemnonov, S. A., FINE STRUCTURE OF THE FUNDAMENTAL K ABSORPTION EDGE OF TRANSITION METALS OF THE IRON GROUP, THEIR ALLOYS, AND COMPOUNDS. (In Russian.) *Izvest. Akad. Nauk S.S.S.R. Ser. Fiz.* 24, 447-454 (1960). Trans: *Bull. Acad. Sci. U.S.S.R. Phys. Ser.* 24, (In Process.)

- 1,3a. K absorption measurements are tabulated for Cr, Mn, Fe, Co, Ni, Cu, Zn and their oxides, sulfides, halides and sulfates; tabular data are also presented for Fe containing 17, 25, 50, and 75 at/o Al.
- 3b. In the compounds the fundamental K edge is shifted 8-15 eV towards higher energies than in the pure metal.
4. With increasing Al content, the superposed 3d-4s bands of iron are filling with p type electrons.

(35)E

Nemnonov, S. A. and L. D. Finkel'shtein, THE CHARACTER OF THE INTERATOMIC INTERACTION OF HYDRIDES OF SOME TRANSITION METALS. (In Russian.) *Fiz. Metal. i Metallovedne* 2, 530-534 (1960). Trans: *Physics of Metals and Metallography* 2 (4), 48-51 (1960).

1. The K absorption edge of V pure and alloyed with 45 at/o H was studied.
2. A bent crystal (quartz) spectrograph was used.
- 3a. The long wave VH lines were considerably less intense than those of pure V.
- 3b. The V and H bond in VH is nonlocalized (mixed covalent and ionic).
4. The VH long wave spectra are explained by a screening loss in the 3d4s band by the 4p band due to the interatomic distance increase on alloying.

(36)E

Nemnonov, S. A. and A. Z. Menshikov, X-RAY ABSORPTION SPECTRA OF CHROMIUM IN CHROMIUM SILICIDES. (In Russian.) *Fiz. Metal. i Metallovedne* 2, 385-389 (1960). Trans: *Physics of Metals and Metallography* 2 (3), 57-61 (1960).

1. The silicides Cr<sub>3</sub>Si, Cr<sub>3</sub>Si<sub>2</sub>, CrSi and CrSi<sub>2</sub> were studied.

(36)E Cont'd.

3. Changes in the K edge showed that the number of electrons participating in the Cr-Cr bond decreased while the Cr-Si bond electrons increased with increasing Si content.
4. The bond is a mixed covalent-metallic up to  $\text{CrSi}_2$  when covalency becomes prevalent.

(37)E

- Nemnonov, S. A. and M. F. Sorokina, THE FUNDAMENTAL K-ABSORPTION EDGE OF NICKEL IN NICKEL-ALUMINUM ALLOYS. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 455-460 (1960) Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process).
1. Pure Ni,  $\text{Ni}_3\text{Al}$ ,  $\text{NiAl}$  and  $\text{NiAl}_3$  were studied.
  2. A bent crystal spectrograph was used.
  3. The 3d band is full in  $\text{NiAl}$  and  $\text{NiAl}_3$  and nearly so in  $\text{Ni}_3\text{Al}$ .

(38)E

- Nemnonov, S. A., M. F. Sorokina and L. D. Fin, INVESTIGATION OF THE K ABSORPTION SPECTRUM OF SMALL ADDITIONS OF ZINC IN ZINC ALUMINUM ALLOYS. (In Russian.) Fiz. Metal. i Metallovedne 10, 148-150 (1960). Trans: Physics of Metals and Metallography 10 (1), 142-144 (1960).
1. The K absorption edge of Al and of Zn in an alloy of Al containing 1.7 weight percent Zn was studied.
  2. A film of alloy 210 $\mu$  thick was photographed using a bent crystal (quartz) spectrometer as the dispersing agent.
  - 3a. A comparison curve for the absorption edges of Al and Zn in the alloy vs. the K edge of pure Zn is given; the Zn edge is shifted to 0.8 eV toward lower energies.
  - 3b. Details of the observed fine structure are tabulated.
  4. The conduction band of the alloy is common to both elements.

(39)E

- Neupert, W. M., PHOTON ABSORPTION BY VALENCE ELECTRONS IN ALUMINUM, NICKEL, AND COPPER. Thesis, Cornell University (1960). Univ. Microfilms MIC 60-880, 107 pp. Diss. Abs. 20, 4142-4143 (1960).
1. Maxima near L absorption edges in Al and near M absorption edges in Cu were investigated.
  - 2a. A normal incidence vacuum spectrograph was modified to operate in the energy region 50 to 15 eV (200-900A); the resolution near the high energy end is better than 0.1 eV.
  - 2b. Thin films formed directly in the chamber were investigated; the area densities ranged from 15 to 34  $\mu\text{g}/\text{cm}^2$ .
  3. All observed absorption maxima in the three metals are tabulated.
  4. Collective oscillations (plasmons) as well as interband transitions may participate in the attenuation of the incident beam; how-

ever, it is felt that the dominating process is the interband transition.

(40)E

Nigam, A. N. and K. S. Srivastava, FORBIDDEN TRANSITION LIMIT IN THE SPECTRUM OF PLATINUM (78). J. Sci. & Ind. Research (India) 198, 111-112 (1960).

- 1,2. A curved crystal (mica) spectrograph having a dispersive power of 5.8 XU/mm was used to study the L emission spectrum of Pt; intensities were recorded photographically with exposure times of 6-8 hours.
3. A faint line was observed at 1167.3 XU ( $\nu/R = 780.66$ ) which is believed to be due to the  $L_{II}M_I$  transition in Pt.

(41)E

Nikolaeva, L. G. and S. M. Karal'nik, THE BASIC K-EDGE ABSORPTION OF X-RAYS OF IRON AND VANADIUM IN THEIR ALLOYS AND TWO MODIFICATIONS. (In Ukrainian.) Ukrain. Fiz. Zhur. 5, 231-234 (1960). Annotation from Chem. Abs. 55, 1176 i.

1. The K edges in FeV alloys and in  $\alpha$  and  $\sigma$  phase modifications were studied.
3. The short wave displacement in the alloys attained a peak of 4 to 5 eV in the middle concentration range.
4. The  $\alpha \rightarrow \sigma$  transformation was attended by the transfer of Fe 3d electrons to V atom outer levels.

(42)E

Ovsyannikova, I. A. and I. B. Borovskii, FINE STRUCTURE OF THE X-RAY K SPECTRA OF SOME SULFIDES. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 435-440 (1960). Trans: Bull. Acad. Sci. U.S.S.R. Ser. Phys. 24, (In Process.)

1. The K absorption edges and satellites in Cu, S, CuS, Ni, NiBi, and NiS were studied.
2. A bent crystal spectrometer was used and the spectra were photographically recorded.
- 3a. Copper in CuS changes in the direction of a zinc spectrum indicating the promotion of a 3p electron in sulfur to a conduction electron of the 4s variety.
4. Both copper and sulfur contribute electrons to the conduction band.

Pike, E. R., - See Review (R-11).

(43)A

Rumsh, M. A., A. P. Lukirskii and V. N. Shchemelev, PHOTOEFFECT FOR METALLIC CATHODES IN THE WAVELENGTH REGION FROM 1.39 TO 13.3 A.

(43)A Cont'd.

Doklady Akad. Nauk U.S.S.R. 135, 55-57 (1960).  
(In Russian.)  
Trans: Soviet Physics "Doklady" 5, 1231-1233 (1960).

1. The quantum yield,  $K$ , measured at  $\theta = 10^\circ$ , where  $\theta$  is the angle of incidence, is given for W, Ni, and Be photocathodes in the range 1.389A to 13.33A.
2. See Ref. #30 (1960) for a description of the methods used.
3. Results for each photocathode are tabulated at nine points within the stated wavelength region.

(44)A

Rumsh, M. A., A. P. Lukirskii and V. H. Shchemelev, A VACUUM X-RAY MONOCHROMATOR FOR DETERMINING THE ABSOLUTE EFFICIENCY OF RADIATION RECEIVERS. (In Russian.)  
Priory i Tekhnika Eksperimenta No. 5, 67-73 (1960).  
Trans: Instruments and Experimental Techniques 1960, 755-761.

1. A flat crystal Bragg type monochromator capable of being used in the 1A to 19.3A region is described in great detail; a cutaway isometric view is also provided.

- 3a. Using the expression

$$N_0 = \frac{K_4 K_5}{K_1 K_2 (1 - K_3)} N$$

where  $N_0$  is the number of quanta falling on a flow proportional type counter per second,  $N$  is the observed counting rate,  $K_1$  is the transmittance of the entrance window,  $K_2$  and  $K_3$  are the transmittances of the gas in the tube,

$K_4$  is the counting loss factor, and  $K_5$  is a factor for extraneous pulses, a special counter tube is designed which enabled the authors to measure  $K_1$ ,  $K_2$ , and  $K_3$ . The terms for  $K_4$  and  $K_5$  were calculated.

- 3b. Results for Cu, Ti, Cl, Al, Na, and F are shown graphically.

(45)T

Shiraiwa, T., THEORY OF THE FINE STRUCTURE OF THE X-RAY ABSORPTION SPECTRUM.  
J. Phys. Soc. Japan 15, 240-250 (1960).

1. State lifetimes are considered. It is assumed that the inelastic cross-section of collision between the electron and an atom is of the order of 1 square A.
2. Using this assumption, Kronig's method is applied in order to obtain transition probabilities.
- 3a. The scattering amplitude for the Hartree field of the atom is numerically calculated.
- 3b. The method is applied to the K absorption spectra of Cu, Ti, rutile, and anatase, and good agreement with experimental results is

obtained except for the Ti-oxides.

- 3c. Calculated spectra are presented in detail.

(46)T

Shmidt, V. V., ON THE EFFECT OF INTERELECTRON INTERACTION IN METALS ON THE FINE STRUCTURE OF X-RAY SPECTRA. (In Russian.)  
Zhur. Eksptl. i Teoret. Fiz. 39, 1269-1275 (1960).

Trans: Soviet Physics "JETP" 12, 886-890 (1961).

1. An attempt is made to solve the problem of finding the absorption coefficient taking into account the interaction between an electron which has absorbed an X-ray quantum with all the free electrons of the metal.
2. The free electron theory of Slater is used to determine the ratio of the absorption coefficient with plasma production to that given by the single-electron theory.
- 3a. The ratio is given as Ti = 5, Cr = 1, and Fe = 0.1.
- 3b. The results are confirmed by the fact that, in experimental work, the fine structure details decreased in the order Ti, V, Cr, Fe and disappeared in Ni.

(47)T

Shuvaev, A. T., INTERPRETATION OF X-RAY SPECTRA. (In Russian.)  
Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 424-427 (1960).  
Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24, (In Process.)

1. A change in the K edge is assumed to be due to a change in the 1s level upon removal of a 4s electron by valence bonding.
2. By using a self-consistent field method, a value of 0.15 eV is calculated for the screening constant change of Ca, Fe, and Zn.
3. The magnitude of  $K\beta_5$  (conduction  $\rightarrow$  K band transitions) line displacement is about 2 eV for removal of a d electron and 1 eV for  $s \rightarrow d$  and  $s \rightarrow p$  changes.
4. Inner screening by 3p and 4s levels in elements of  $Z = 20-29$  increases because the d levels are filling.

(48)E

Singh, J. N., FINE STRUCTURE OF THE K X-RAY ABSORPTION EDGE OF GERMANIUM.  
Thesis to Washington State University.  
Univ. Microfilms MIC 60-5350, 92 pp.  
Diss. Abs. 21, 2343 (1961).

1. A thin (12.5 $\mu$ ) single crystal of Ge was investigated by means of the transmission method; only the high energy side of the K edge was studied.
2. A double crystal (quartz and calcite) spectrometer was used; a proportional counter was employed to obtain intensity data.
- 3a. New features were observed in the absorption structure; the results could be explained by Hayashi's theory and by Kronig's theory.
- 3b. A necessary proof of the  $\cos^2\theta$  dependence in the Kronig theory is provided by the results.



(49)T

Taylor, G. R. and W. B. Payne, RETARDATION AND K X-RAY RELATIVE INTENSITIES.  
Phys. Rev. 118, 1549-1551 (1960).

1. The matrix elements are numerically evaluated for electric dipole transitions with retardation for transitions between the 1s and higher states of a single Dirac electron in a coulomb field.
- 3a. The relative intensities of the principal K X-ray lines in elements of high atomic number are tabulated.
- 3b. Data on the relative intensity of  $K\alpha_2:K\alpha_1$ ;  $K\beta_3:K\beta_1$ ; and  $K\beta_1:K\alpha_1$  are presented.
4. The effect of retardation is more significant than screening effects only when the total angular momentum of the electron changes; this effect shows itself in the  $K\alpha_2:K\alpha_1$  intensity ratio in lead.

(50)A

Tomboulion, D. H., THE PERFORMANCE OF A Be-Cu PHOTOMULTIPLIER IN THE 100A TO 300A REGION.  
U.S. At. Energy Comm. NP-8475, 29 pp. (1960).

- 1,2. A Be-Cu photomultiplier was used to count quanta in absorption coefficient determinations in the 100-300A region.
3. The reliability of the photomultiplier is carefully outlined.

(51)T

Tomboulion, D. H., THE ANGULAR DISTRIBUTION OF THE SYNCHROTRON RADIATION IN THE EXTREME ULTRA-VIOLET AND X-RAY REGIONS.  
Office of Ordnance Research, Project #2486, Tech. Rept. #1, (1960).

1. Classical and quantum theories of electromagnetic radiation of high energy electrons in circular motion are explored.
2. The classical equation for the power radiated per unit solid angle into the Nth harmonic of the circular frequency is put into a form suitable for calculations, and the results of the quantum theory are compared with this classical expression.
- 3a. Curves of the angular power distribution for four wavelengths (108.6, 10.86, 1.086 and 0.1086 A) in the region of most intense radiation are computed for a Cambridge-like accelerator at maximum energy (orbital radius = 26.26 meters, energy = 6 Bev).
- 3b. The polarization of this radiation is also calculated, as well as the angular distribution of the total power radiated into all wavelengths.

(52)E

Tomboulion, D. H., SOFT X-RAY PHOTON COUNTER-STABILIZATION OF SOURCE.  
Office of Technical Services, PB 158025, Tech. Rept. #4, 14 pp. (1960).

1. The methods adopted for regulating the X-ray tube current and potential are described.
2. Circuitry and behavior of the voltage and current regulators are discussed.
- 3a. The X-ray potential is regulated by a commercial line voltage regulator.

The regulator is modified so that the controlling signal is derived directly by sampling a fraction of the DC target voltage.

- 3b. The X-ray tube current is regulated by an electronic circuit which, in effect, changes the impedance in the primary circuit of the X-ray filament heater transformer to compensate for changes in the X-ray tube current.

(53)E

Vainshtein, E. E., E. A. Zhurakovskii, V. S. Neshpor, and G. V. Samsonov, FINE STRUCTURE OF X-RAY K SPECTRAL ABSORPTION AND THE HALL EFFECT IN VANADIUM SILICIDES. (In Russian.) Doklady Akad. Nauk S.S.S.R. 134, 68-70 (1960). Trans: Sov. Phys. "Doklady" 5, 996-998 (1961).

1. The substances studied were  $V_3Si$ ,  $V_5Si_3$ , and  $VSi_2$  containing not more than 0.6% free Si; the K absorption edge was investigated.
2. A curved crystal (quartz) spectrograph was used.
- 3a. The absorption maximum shifts towards higher energies with increasing silicon content.
- 3b. Spectra are presented and a table of results is given.
4. The short wavelength displacement of the maximum may be connected with the perturbation of the vanadium "d" states by the neighboring silicon atoms.

1960 (C)

(C-1)A

Baez, A. V., A SELF-SUPPORTING METAL FRESNEL ZONE PLATE TO FOCUS EXTREME ULTRAVIOLET AND SOFT X-RAYS.  
Nature 186, 958 (1960).

1. A Fresnel zone-plate consisting of 19 metal zones held together by thin radial struts was prepared.
2. The zone-plate was produced by lithographic techniques; it is 10 microns thick and the narrowest gold band has a width of 20 microns.
3. Tests were made at 6700, 4358 and 2537 A; at 1000A the zone-plate is faster than any lens.
4. The zone-plate will give excellent resolution down to 100A.

(C-2)T

Blokhin, M. A. and V. P. Sachenko, FORM OF THE ENERGY BANDS FOR A SOLID. (In Russian.) Izvest. Akad. Nauk S.S.S.R. Ser. Fiz. 24, 397-406 (1960).

(C-2)T Cont'd.

Trans: Bull. Acad. Sci. U.S.S.R. Phys. Ser. 24 (10), (In Process.)

1. The amount of level broadening occurring as the free electron state is approached, was calculated.
3. The effect of this broadening on X-ray emission bands and on electron distribution within the band is enumerated.

(C-3)E

Coles, B. R., ELECTRICAL RESISTIVITY AND THE ELECTRONIC STRUCTURE OF  $\text{Cu}_3\text{Au}$ . Physica 26, 143-144 (1960).

1. It is stressed that a direct indication of a reduction, upon ordering, of the freedom of conduction electrons in  $\text{Cu}_3\text{Au}$  can be found in the electrical resistance.
3. A table of resistivity is given for ordered and disordered types of  $\text{Cu}_3\text{Au}$  at 273 and 4.2°K; the temperature effect on the Brillouin zone structure is discussed.

(C-4)T

Cornwell, J. F. and E. P. Wohlfarth, AN ENERGY BAND INTERPOLATION SCHEME WITH APPLICATION TO BODY-CENTERED CUBIC LITHIUM. Nature 186, 379-380 (1960).

- 1,2. The energy bands in BCC-Li were calculated using plane wave expansions of the wave functions and accurately known values of the energy levels at high-symmetry points in the Brillouin zone; for valence states having the same symmetry as the ion cores, the expansion includes a repulsive pseudo-potential ( $V_r$ ).
3. A calculated band structure and a density of states curve are presented; the Fermi energy was -0.425 Ry and the Fermi surface does not touch the zone boundary.

(C-5)T

Curie, D., CALCULATION OF EMISSION STRUCTURE IN THE CONFIGURATION COORDINATE MODEL. (In French) Compt. Rend. (French Academy) 250, 834-836 (1960).

- 1,3. A simple derivation is presented for emission and absorption bandwidths at 0°K, for the increase of bandwidth with temperature elevation; and for band displacement due to an elevation of temperature.

(C-6)E

Dawber, K. R., PHOTOELECTRIC YIELD FROM ADSORBED GAS LAYERS IN THE SOFT X-RAY REGION. Rev. Sci. Inst. 31, 210-211 (Feb. 1960).

1. The photoelectric yield of Allen type photomultipliers was determined as a function of temperature, pressure, and time after firing.
2. A 10-stage photomultiplier assembly was mounted without an envelope in a vacuum system containing a 200-300A X-ray source (Al target). The photosensitive first plate of

the photomultiplier was made interchangeable and specimens of Be-Cu both clean and oxidized, Cu, Al, Ta and stainless steel were examined. The metal components could be rf vacuum fired, or the whole high-vacuum section could be baked out. The photomultiplier could be operated immediately after either heat treatment had ceased.

- 3a. Pyrofilm resistors between multiplier stages stood up well to 400°C bakeout or rf heating of the plates to 800°C.
- 3b. The results showed that the yield from clean metal or alloy surfaces was negligible compared to that from the adsorbed gas.
- 3c. Stable multilayer adsorption occurred on Cu above pressures of  $1.5 \times 10^{-5}$  mm Hg; below this pressure only monolayer adsorption appeared stable.
- 3d. Time variations in yield at constant temperature were noted only at pressures below  $1.5 \times 10^{-5}$  mm Hg and showed no reproducibility.
4. The method of this experiment offers new means for investigating gas adsorption phenomena.

(C-7)E

Eley, D. D. and P. R. Wilkenson, ADSORPTION AND OXIDE FORMATION ON ALUMINUM FILMS. Proc. Roy. Soc. (London) A-254, 327-343 (1960).

1. The kinetics of oxygen uptake were followed at a pressure of  $10^{-2}$  to  $10^{-3}$  mm Hg.
- 3a. Place exchange of oxygen and aluminum atoms was deduced to be the governing uptake step.
- 3b. An equation for the weight uptake ( $g$ ) was:

$$\frac{dg}{dt} = \left( ae - \frac{\gamma g}{Rt} \right) (\rho^{0.6})$$

where  $a$  and  $\gamma$  are constants.

(C-8)T

Flynn, C. P. and E. F. W. Seymour, THE CORRECTION OF SPECTRAL LINE SHAPES FOR INSTRUMENTAL AND OTHER BROADENING. Proc. Phys. Soc. (London) 75, 337-344 (1960).

1. A rapid method for the correction of line shapes observed in any branch of spectroscopy is presented.
- 3a. The method is useful for distortions governed by the equation:

$$f(X_0) = \int_{-\infty}^{+\infty} g(X)h(X_0-X)dx$$

where  $f(X)$  is the observed line shape,  $g(X)$  the true line shape, and  $h(X)$  an instrumental or intrinsic broadening function provided  $h(X)$  is real and finite.

- 3b. Formulae for the corrections of moments of lines are also given.

(C-9)T

Goodenough, J. B., BAND STRUCTURE OF TRANSITION METALS AND THEIR ALLOYS. Phys. Rev. 120, 67-83 (1960).

1. An exhaustive re-examination of the band

(C-9)T Cont'd.

structure of the transition metals is presented with 95 references.

2. Several theoretical models are used.
3. (1) Density of states curves, (2) qualitative features of the band structures for the various transition metal crystal lattices, (3) the relation between d-orbital vs. neighbor configuration symmetry, band occupation and band characteristics in pure metals are presented.

(C-10)E

Hagstrom, H. D. and C. D'Amico, PRODUCTION AND DEMONSTRATION OF ATOMICALLY CLEAN SURFACES. Jour. Appl. Phys. 31, 715-723 (1960).

1. The cleaning of solid surfaces by means of ion bombardment was tested by applying it to the metal tungsten.
2. Surface conditions during the cleaning procedures were observed by means of Auger-type ejection of electrons by slowly moving positive ions.
3. This effect is capable of detecting changes in surface concentration of foreign atoms which amount to a few percent of a monolayer.
4. Ion bombardment produces the same surface as is produced by high-temperature flashing (2200°K).

(C-11)I

Horak, Z., ORIGIN OF THE  $K\beta'$  LINE ACCORDING TO THE ANGULAR MOMENTUM COUPLING HYPOTHESIS. Czech. J. Phys. 10, 405-406 (1960) (In English)

- 1,2. The Coster-Druyvesteyn theory is used to calculate the  $K\beta'$  satellite structure in free  $Mn^{++}$  and  $Fe^{+++}$  ions.
3. Calculated results are in fair agreement with those measured by other workers; a table is given.
4. The  $K\beta'$  originates from an angular momentum coupling.

(C-12)T

Jaegle, P., CALCULATION OF THE RESOLVING POWER OF A SPECTROGRAPH WITH TWO CONCAVE GRATINGS AT GLANCING INCIDENCE. (In French.) Compt. Rend. (French Academy) 250, 3620-3621 (1960).

1. The intensity distribution of the diffracted X-ray beam from a double grating spectrograph at grazing incidence is examined.
3. The resolution should be greatly improved without intensity loss by adding the second grating in a suitable position.

(C-13)T

Klemens, P. G., BAND STRUCTURE OF MONOVALENT METALS AND THEIR ALLOYS. Australian J. Phys. 13, 238-246 (1960).

- 1,2. Bloch theory is used in an attempt to evaluate the conduction properties of metals.
- 3a. The Bloch theory can only be used with a spherical and isotropic Fermi surface.
- 3b. The Fermi surface of monovalent metals is examined mathematically and the form of the transport equation for electrical and thermal

conduction is given based on these data.

(C-14)T

Lipscomb, W. N. and D. Britton, VALENCE STRUCTURES OF THE HIGHER BORIDES. J. Chem. Phys. 33, 275-280 (1960).

1. An attempt to systematize the valence orbital structures of the boron frameworks in  $MB_2$ ,  $MB_4$ ,  $MB_6$ ,  $MB_{12}$ ,  $B_{12}C_3$  and pure boron is made.
2. The B framework is isolated into polyhedra connected by localized bonds and the molecular orbitals of the individual polyhedra are investigated. Then electrons are "transferred" from the more electropositive element to the B framework until the bonding orbitals are filled.
- 3a. Excess valence electrons on the metal atoms are regarded as metallic in character.
- 3b. The procedure outlined above is carried out in detail, and the results are diagrammed.

(C-15)T

Murrell, J. N., CONSTRUCTION OF HYBRID ORBITALS. J. Chem. Phys. 32, 767-770 (1960).

1. A method to construct the "best" hybrid orbitals is presented.
2. The method is based on the use of the principle of maximum overlap.
3. The method is illustrated by use of the example of Cl in  $ClF_3$ .

(C-16)E

Nemnonov, S. A., L. D. Finkel'shtein and K. M. Kolobova, AN X-RAY SPECTRAL AND X-RAY DIFFRACTION INVESTIGATION OF THE INTERATOMIC BONDING FORCES IN IRON-ALUMINUM ALLOYS. (In Russian.) Fiz. Metal. i Metallovedne 9, 243-247 (1960). Trans: Physics of Metals and Metallography 9 (2), 71-75 (1960).

1. Irons containing 2, 4, 10, 17, 25, and 50 atomic percent Al were annealed at various temperatures ranging from 380°C to 470°C and the Debye temperature determined.
- 3,4a. The appearance of the K-state on annealing is responsible for the strengthening of the Fe-Al bond.
- 4b. Iron is electronegative to aluminum in Fe-Al alloys.

(C-17)T

Nordfors, B., THE STATISTICAL ERROR IN X-RAY ABSORPTION MEASUREMENTS. Arkiv Fysik 18, 37-47 (1960).

1. The case for counter registration is studied; the influence of background radiation is also surveyed.
- 3a. The optimum conditions for absorber thickness and for the time distribution between measuring  $I$  and  $I_0$  are found, and these values are plotted.
- 3b. A two-page table giving the optimum conditions for different backgrounds is presented.



(C-18)E

Phillip, H., E. A. Taft and L. Apker, PHOTOEMISS-  
ION AND VALENCE BAND STRUCTURE OF ALKALI  
IODIDES.

Phys. Rev. 120, 49-51 (1960).

1. The energy distributions for external photoelectrons ejected from CsI by 11.3 eV photons were studied.
2. Energy distributions were determined in sealed-off phototubes with spherical collectors by retarding potential methods.
- 3a. All but 5% of the ejected photoelectrons ranged in energy from 1.5 to 5.3 eV.
- 3b. The energy distributions of intrinsic photoelectrons from KI, NaI, CsBr, CsLi, CsI, and RbI are presented in graphical form.
- 3c. Photon energies equal to twice the forbidden band gap are sufficient to eject photoelectrons from the bottom of the valence band.
4. The valence bandwidth is 3 to 4 eV below the vacuum level.

(C-19)E

Rustgi, O. P., THE OPTICAL AND PHOTOELECTRIC  
PROPERTIES OF METALS IN THE VACUUM ULTRA-  
VIOLET REGION OF THE SPECTRUM.

Thesis, University of Southern California  
(1960). Univ. Microfilms MIC 60-4486, 87 pp.  
Diss. Abs. 21, 1609 (1960).

1. The metals, Al, Sn, In, Bi, Te, Au, Ag, Cd, Sb, Ti, and Ge were investigated in the region 1600A to 450A.
2. The transmissivity and the photoelectric yield were observed in thin films of the above metals in the path of a normally incident beam.
- 3a. The photoelectric yield increased in regions where the reflectivity declined.
- 3b. Values for the reflection-transmission transition are given.
4. The results lead to a conclusion that plasma oscillations caused by high energy electrons striking a metal are not necessarily excited by photons.

(C-20)T

Wilmschurst, J. K., ORBITAL RADII AND THE DEPEND-  
ENCE OF BOND LENGTH UPON IONICITY, HYBRIDI-  
ZATION AND BOND ORDER.

J. Chem. Phys. 33, 813-820 (1960).

1. Atomic orbital radii are obtained for elements in the first four periods except for transition metals.
2. These orbitals were obtained by using known bond length data and a derived expression for bond ionicity.
3. Results are presented in tabular form for about 75 atoms and molecules.

1960 - Supplemental.

(Papers which did not appear in print until 1961,  
although they carry a 1960 date.)

S-1

Hayashi, T., THE K AND L<sub>2,3</sub> ABSORPTION SPECTRUM  
OF ALUMINUM.

Sci. Repts. Tohoku Univ., 1st Ser. 44 (3)  
87-94 (1960).

1. The Hayashi theory of quasi-stationary electron states, (See e.g. Refs. 1949 (2), 1950 (9)) is applied to the K and L<sub>2,3</sub> absorption spectra of Al.
- 3a. Experimental spectra of other workers are shown along with the corresponding appropriate quasi-stationary states.
- 3b. The energy of d and s quasi-stationary states of Al is tabulated.
- 4a. The fine structure of the L spectra is thought to correspond to the absorption process L<sub>2,3</sub> → s quasi-stationary state in the wave-length region greater than the absorption edge.
- 4b. No fine structure is expected in the wave-length region greater than the absorption edge for the K spectra.

S-2

Hayashi, T. and T. Sagawa, THE ABSORPTION SPECTRUM  
OF METALLIC ALUMINIUM IN THE WAVELENGTH  
RANGE OF THE Al-L<sub>2,3</sub> EMISSION BAND.

Sci. Repts. Tohoku Univ., 1st Ser. 44 (4),  
126-134 (1960).

1. Both the emission and absorption Al-L<sub>2,3</sub> bands were photographed in the wavelength range 170-200A.
- 2a. See Ref. 1960 (S-3) for details of the experimental procedure.
- 2b. Absorbers were foils of Al 2,750A thick (determined by weighing and by colorimetric microanalysis).
- 3a. The absorption coefficient ( $\mu$ ) was found to be about  $3.0 \times 10^4 \text{ cm}^{-1}$  in the range 170-200A.
- 3b. Fine structure was found on the long wave-length side of the Al-L<sub>2,3</sub> absorption edge.

S-3

Sagawa, T., THE L<sub>2,3</sub> EMISSION SPECTRUM OF METALLIC  
ALUMINIUM.

Sci. Repts. Tohoku Univ., 1st Ser. 44 (4)  
115-125 (1960).

1. A new grazing incidence grating spectrograph was constructed; Al was the first substance to be studied.
- 2a. The spectrograph employs a Siegbahn grating having 576 lines/mm at a grazing angle of 3°29'. Targets were evaporated Al which was excited by radiation from a W filament. Target current was 100 ma at 2 kv.
- 2b. The spectrometer uses photographic photometry to obtain intensity data.
- 2c. The vacuum was  $4-8 \times 10^{-6}$  mm Hg.
- 2d. The resolution in the third order was 0.02 eV; carbon K $\alpha_1$  was not significant in this order.
- 3a. The observed band is presented and compared with bands obtained by other workers.
- 3b. The features of the observed band are tabulated; the total band width was 14.8 eV.
- 3c. The experimental Al band was compatible with the results of earlier work.

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1960	<u>24</u> (4)	435-440	(42)
1960	<u>24</u> (4)	441-442	(7)
1960	<u>24</u> (4)	443-446	(6)
1960	<u>24</u> (4)	447-454	(34)
1960	<u>24</u> (4)	455-460	(37)
1960	<u>24</u> (4)	461-464	(22)
1960	<u>24</u> (4)	465-469	(23)
1960	<u>24</u> (4)	473-475	(20)

# IZVESTIA SEKTORA FIZIKO-KHIMICHESKOGO ANALIZA

1953	<u>22</u>	104-110	(C-6)
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## JOURNAL DE CHIMIE PHYSIQUE (J. Chim. Phys.)

1950	<u>47</u>	892-897	(2)
1954	<u>51</u>	76-88	(6)

## JOURNAL DE PHYSIQUE ET LE RADIUM (J. Phys. Radium)

1952	<u>13</u>	113-121	(7)
1952	<u>13</u>	505-515	(8)
1954	<u>15</u>	Suppl. to No. 1	16A-22A (23)
1955	<u>16</u>	253-262	(7)
1955	<u>16</u>	271-273	(25)
1955	<u>16</u>	422-427	(26)
1955	<u>16</u>	644-649	(C-4)
1958	<u>19</u>	573-581	(C-8)

## JOURNAL OF APPLIED PHYSICS (J. Appl. Phys.)

1949	<u>20</u>	1141-1147	(6)
1957	<u>28</u>	98-105	(20)
1958	<u>29</u>	804-809	(C-20)
1960	<u>31</u>	715-723	(C-10)

## JOURNAL OF CHEMICAL PHYSICS (J. Chem. Phys.)

1951	<u>19</u>	528-533	(C-4)
1952	<u>20</u>	1298-1301	(19)
1956	<u>25</u>	142-146	(C-5)
1956	<u>25</u>	617-619	(6)
1956	<u>25</u>	619-623	(7)
1957	<u>26</u>	1758-1759	(42)
1958	<u>28</u>	83-87	(6)
1960	<u>32</u>	767-770	(C-15)
1960	<u>33</u>	275-280	(C-14)
1960	<u>33</u>	813-820	(C-20)

## JOURNAL OF THE CHEMICAL SOCIETY (LONDON) (J. Chem. Soc. - London)

1954	<u>1954</u>	332-357	(C-2)
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## JOURNAL OF THE CHEMISTRY AND PHYSICS OF SOLIDS (J. Chem. Phys. Solids)

1957	<u>2</u>	67-71	(34)
1957	<u>23</u>	282-302	(37)
1958	<u>6</u>	99	(C-11)
1958	<u>6</u>	178-179	(1)
1958	<u>7</u>	65-77	(C-16)
1959	<u>8</u>	382	(C-6)
1959	<u>10</u>	87-98	(C-13)
1959	<u>10</u>	147-161	(C-30)

## JOURNAL OF THE LESS COMMON METALS (J. Less Common Metals)

1959	<u>1</u>	396-411	(C-23)
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JOURNAL OF THE OPTICAL SOCIETY OF AMERICA  
(J. Opt. Soc. Am.)

1932	<u>22</u>	245-264	(3)
1945	<u>35</u>	311-352	(C-1)
1955	<u>45</u>	756-761	(31)
1958	<u>48</u>	690-703	(C-17)
1959	<u>49</u>	446-459	(C-18)
1959	<u>49</u>	460-465	(C-18)
1959	<u>49</u>	471-475	(C-27)
1959	<u>49</u>	593-602	(C-11)
1959	<u>49</u>	609-618	(C-26)
1959	<u>49</u>	951-960	(C-18)
1959	<u>49</u>	961-965	(C-19)

JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN  
(J. Phys. Soc. Japan)

1952	<u>7</u>	451-457	(C-2)
1952	<u>7</u>	644-645	(24)
1955	<u>10</u>	647-650	(28)
1956	<u>11</u>	657-661	(22)
1956	<u>11</u>	676-689	(C-10)
1957	<u>12</u>	793-801	(39)
1958	<u>13</u>	586-590	(35)
1958	<u>13</u>	766	(C-19)
1958	<u>13</u>	847-859	(29)
1959	<u>14</u>	913-917	(C-9)
1959	<u>14</u>	1696-1706	(37)
1960	<u>15</u>	240-250	(45)

JOURNAL OF THE ROYAL INSTITUTE OF CHEMISTRY  
(J. Roy. Inst. Chem.)

1960	<u>84</u>	311-320	R-4
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JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH  
(INDIA) (J. Sci. & Indust. Research - India)

1950	<u>9B</u>	263-265	(5)
1951	<u>10B</u>	260	(4)
1952	<u>11B</u>	1-4	(9)
1952	<u>11B</u>	199-200	(3)
1953	<u>12B</u>	639-641	(5)
1955	<u>14B</u>	129-130	(9)
1956	<u>15B</u>	615-618	(9)
1957	<u>16B</u>	524-527	(28)
1960	<u>19B</u>	111-112	(40)

JOURNAL OF SCIENTIFIC INSTRUMENTS (J. Sci. Instr.)

1958	<u>35</u>	393-395	(5)
1960	<u>37</u>	460-462	(18)

LANDOLT-BORNSTEIN TABLES

1955	1 (4)	6th edition 769-867	R-5
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LIBRARY OF CONGRESS

1953	NSF-tr-7,	3 pp.	(2)
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, RESEARCH  
LABORATORY OF ELECTRONICS (Research Lab. of  
Electronics MIT)

1951	<u>Tech. Rept. 193</u>	30 pp.	(12)
1953	<u>Tech. Rept. 254</u>	34 pp.	(7)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, SOLID STATE  
AND MOLECULAR THEORY GROUP

1959	<u>Tech. Rept. 12</u>	258 pp.	(C-28)
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METHODS OF EXPERIMENTAL PHYSICS - SOLID STATE  
PHYSICS

1959	<u>B-6</u>	281-292	R-10
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MIKROCHIMIKA ACTA (Mikrochim. Acta)

1955	<u>1955</u>	684-695	(15)
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NATURE

1952	<u>169</u>	889	(10)
1956	<u>178</u>	814	(18)
1960	<u>186</u>	379-380	(C-4)
1960	<u>186</u>	958	(C-1)

NATURWISSENSCHAFTEN

1952	<u>38</u>	169-177	(12)
1958	<u>45</u>	309	(8)
1960	<u>47</u>	319	(14)

NAUCHNYI BYULLETEN Leningradskogo Gosudarstvennogo  
ODENA LENINA UNIVERSTETA IMENI A. A. ZHDANOVA  
(Nauch. Byull. Leningrad. - Gosudarst. Univ. IM  
A. A. Zhdanova)

1951	<u>1951</u>	(28) 8-11	(1)
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NAUCH. ZAPISKI KAFIDR. MAT. FIZ. I ESTESTVOZVAN  
ODESS GOSUDARST PEDAGOG INST.

1958	<u>22</u>	(1) 71-76	(15)
1958	<u>22</u>	(2) 60-61	(16)

NAUK POVIDOMLENNYA KIEV UNIVERSITET

1956	<u>1956</u>	(1) 41-42	(14)
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NUCLEONICS

1955	<u>13</u>	(3) 36-37	(12)
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OFFICE OF NAVAL RESEARCH

1950	ONR Report "NAVEXDS"	p-1033 81 pp.	(R-18)
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OFFICE OF ORDNANCE RESEARCH

1960	00R Project No. 2486,	Tech. Rept. No. 1	(51)
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OFFICE OF TECHNICAL SERVICES

1958	PB 135404,	14 pp.	(21)
1958	PB 151453,	117 pp.	R-8
1959	PB 143952,	30 pp.	(30)
1959	PB 144965,	84 pp.	(C-12)
1960	PB 158025,	14 pp.	(52)

OPTICA ACTA

1958	<u>5</u>	31-39	(10)
1959	<u>6</u>	175-185	(C-17)

## OPTICS AND SPECTROSCOPY

1959	7	498-500	(31)
1960	10	297-299	(28)
1960	10	262-265	(29)
1960	10	265-267	(31)
1960	2	343-346	(30)

## OPTIK

1957	14	263-276	(C-7)
1959	16	288-303	(C-10)

## OPTIKA I SPEKTROSKOPIIA

1959	7	850-852	(31)
1960	2	505-508	(29)
1960	2	511-513	(31)
1960	2	653-657	(30)

## PHILOSOPHICAL MAGAZINE (Phil. Mag.)

1949	(7)	40	1260-1269	(1)
1950	(7)	41	144-151	(3)
1951	(7)	42	106-110	(C-1)
1952	(7)	43	153-189	(C-6)
1952	(7)	43	1115-1139	(13)
1953	(7)	44	173-186	(3)
1953	(7)	44	1154-1160	(C-2)
1954	(7)	45	727-734	(C-7)
1954	(7)	45	1070-1080	(21)
1955	(7)	46	77-86	(10)
1956	(8)	1	759-770	(11)
1957	(8)	3	185-203	(C-10)
1959	(8)	3	1424-1431	(9)
1959	(8)	4	1145-1149	(C-3)
1959	(8)	4	1164-1170	(10)
1960	(8)	5	525-527	(11)
1960	(8)	5	1161-1169	(10)
1960	(8)	2	1205-1216	(12)

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY  
(LONDON) (Phil. Trans. Roy. Soc. - London)

1940	A239	95-134	(6)
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## PHYSICA

1948	14	175-183	(1)
1950	16	377-378	(11)
1954	20	801-812	(C-4)
1954	20	1135-1137	(15)
1955	21	85-102	(37)
1956	22	706-706	(2)
1960	26	143-144	(C-3)

## PHYSICAL REVIEW (Phys. Rev.)

1929	34	574-581	(1)
1931	38	1802-1807	(1)
1932	40	477-483	(2)
1932	42	591-608	(1)
1933	44	605-609	(2)
1933	44	955-960	(1)
1934	45	379-384	(1)
1935	48	133-135	(2)
1935	48	664-670	(C-1)
1935	48	722-724	(1)
1936	49	1-8	(6)
1936	49	132-139	(2)
1936	49	502-507	(3)

1936	50	1-15	(4)
1936	50	598-602	(5)
1936	50	1006-1011	(7)
1939	56	137-142	(5)
1939	56	142-146	(2)
1939	56	146-152	(6)
1939	56	387-391	(4)
1939	56	392-405	(1)
1940	57	786-791	(5)
1940	58	387-395	(2)
1940	58	396-399	(1)
1940	58	400-406	(3)
1941	59	381-385	(2)
1941	59	422-423	(3)
1942	62	137-140	(2)
1948	74	1887	(2)
1950	80	281-282	(4)
1951	82	616-621	(7)
1951	83	1196-1201	(18)
1951	84	362	(14)
1951	84	944-949	(11)
1952	85	685-686	(17)
1952	85	1060	(11)
1952	87	861-862	(15)
1953	91	1382-1387	(C-4)
1953	91	1577-1578	(8)
1953	92	88-89	(17)
1953	92	556-560	(18)
1953	92	1434-1437	(12)
1954	93	365-369	(11)
1954	93	401-405	(C-8)
1954	94	1072	(13)
1954	94	1498-1524	(C-10)
1954	94	1585-1589	(12)
1954	95	621	(2)
1954	95	840-841	(20)
1954	95	1097	(C-5)
1954	96	849	(22)
1955	97	52-54	(39)
1955	97	916-926	(24)
1955	97	1653	(C-6)
1955	98	901-902	(C-3)
1955	98	1020-1028	(C-5)
1955	98	1039-1045	(C-7)
1955	99	1833-1835	(C-8)
1956	101	1469-1472	(3)
1956	102	1423-1447	(C-11)
1956	104	52-56	(C-6)
1956	104	590-597	(1)
1957	105	681-682	(C-11)
1957	105	1156-1157	(18)
1957	105	1228-1232	(33)
1957	105	1483-1485	(C-8)
1957	106	1163-1164	(C-13)
1957	107	62-64	(1)
1957	107	64-68	(C-4)
1957	107	698	(C-1)
1957	108	217-221	(C-5)
1957	108	658-659	(2)
1958	109	35-40	(33)
1958	109	51-54	(9)
1958	110	1590	(2)
1958	110	79-84	(18)
1958	110	685-695	(C-4)
1958	110	776	(30)
1958	110	876-878	(32)
1958	112	322-325	(C-3)
1958	112	344-361	(C-2)
1958	112	685-695	(C-4)
1958	112	1183-1186	(22)
1959	113	464-470	(3)



# PHYSICAL REVIEW (Continued)

1959	<u>113</u>	470-472	(34)
1959	<u>113</u>	1057-1060	(C-8)
1959	<u>115</u>	71-74	(15)
1959	<u>116</u>	880-884	(C-15)
1960	<u>118</u>	1549-1551	(49)
1960	<u>120</u>	49-51	(C-18)
1960	<u>120</u>	67-83	(C-9)
1960	<u>120</u>	1205-1207	(2)

# PHYSICAL REVIEW LETTERS (Phys. Rev. Letters)

1959	<u>2</u>	47	(C-2)
1959	<u>2</u>	148	(C-29)

# PHYSICS OF METALS AND METALLOGRAPHY

1957	<u>4</u> (1)	154-155	(C-3)
1957	<u>5</u> (1)	5-12	(38)
1957	<u>5</u> (3)	7-11	(32)
1958	<u>6</u>	125-131	(34)
1958	<u>6</u>	183-185	(19)
1959	<u>7</u> (2)	61-70	(7)
1959	<u>7</u> (2)	130-132	(36)
1960	<u>9</u> (2)	71-75	(C-14)
1960	<u>9</u> (4)	48-51	(35)
1960	<u>9</u> (3)	57-61	(36)
1960	<u>10</u> (1)	142-144	(38)
1960	<u>10</u> (3)	74-79	(33)

# PORTUGALIE PHYSICA

1951	<u>3</u>	117-126	(16)
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# POWDER METALLURGY

1958	<u>1958</u> (1,2)	172-188	(C-18)
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# PRIBORY I TEKNIKA EKSPERIMENTA

1960	No. 5	67-73	(44)
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# PROCEEDINGS OF THE PHYSICAL SOCIETY (LONDON) (Proc. Phys. Soc. - London)

1951	<u>64A</u>	318-319	(17)
1952	<u>65A</u>	192-202	(C-5)
1952	<u>65A</u>	815-825	(C-4)
1952	<u>65A</u>	1015-1022	(26)
1953	<u>66A</u>	333-340	(C-1)
1954	<u>67B</u>	348-356	(17)
1955	<u>68A</u>	322-328	(C-1)
1955	<u>68A</u>	654-656	(23)
1955	<u>68A</u>	717-725	(20)
1955	<u>68B</u>	472-473	(22)
1957	<u>70A</u>	262-274	(C-6)
1957	<u>70A</u>	466-473	(29)
1959	<u>73</u>	924-936	(18)
1959	<u>74</u>	604-608	(17)
1960	<u>75</u>	337-344	(C-8)
1960	<u>76</u>	791-793	(13)

# PROCEEDINGS OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY (Proc. Cambridge Phil. Soc.)

1938	<u>34</u>	109-114	(1)
1939	<u>35</u>	108-113	(3)
1952	<u>48</u>	457-469	(C-3)

# PROCEEDINGS OF THE INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY (Proc. Intern. Congr. Pure and Appl. Chem.)

1947	<u>11</u>	249-259	(C-1)
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# PROCEEDINGS OF THE ROYAL SOCIETY (LONDON) (Proc. Roy. Soc. - London)

1937	<u>A-161</u>	420-440	(1)
1940	<u>A-176</u>	229-262	(4)
1952	<u>A-212</u>	363-376	(C-7)
1957	<u>A-240</u>	145-160	(C-2)
1959	<u>A-249</u>	555-573	(C-1)
1960	<u>A-254</u>	327-343	(C-7)

# PROGRESS OF THEORETICAL PHYSICS (KYOTO) (Progr. Theoret. Phys. - Kyoto)

1958	<u>19</u>	214	(C-21)
1958	<u>20</u>	53-81	(C-22)

# RADIO ENGINEERING AND ELECTRONICS (USSR)

1957	<u>2</u> (3)	99-106	(26)
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# RADIOTEKHNIKA I ELEKTRONIKA (Radiotekh, I Elektron)

1957	<u>2</u>	328-333	(26)
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# REPORTS ON PROGRESS IN PHYSICS

1939	<u>5</u>	257-283	R-15
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# REVIEW OF SCIENTIFIC INSTRUMENTS (Rev. Sci. Instr.)

1951	<u>22</u>	543	(15)
1952	<u>23</u>	8	(22)
1952	<u>23</u>	523-528	(16)
1955	<u>26</u>	747-750	(34)
1958	<u>29</u>	421-424	(11)
1960	<u>31</u>	210-211	(C-6)
1960	<u>31</u>	891-895	(17)

# REVIEWS OF MODERN PHYSICS (Revs. Modern Phys.)

1941	<u>13</u>	1-57	(R-1)
1958	<u>30</u>	59-62	(C-24)
1959	<u>31</u>	616-645	(R-9)

# REVISTA DA FACULDADE DE CIENCIAS (LISBOA) (Rev. Fac. Cienc. Univ. Lisboa)

1954	Ser 3B <u>2</u>	65-140	(10)
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# RUSSIAN JOURNAL OF INORGANIC CHEMISTRY

1959	<u>4</u> (1)	104-105	(41)
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# SCIENCE AND CULTURE (INDIA)

1952	<u>17</u>	479-480	(1)
1956	<u>21</u>	624-626	(7)

# SCIENCE OF LIGHT (TOKYO)

1958	<u>7</u> (2)	23-27	(C-15)
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SCIENCE REPORTS OF THE TOHOKU UNIVERSITY  
(Sci. Repts. Tohoku Univ.)

FIRST SERIES

1941	<u>30</u>	267-286	(1)
1942	<u>31</u>	1-7	(1)
1949	<u>33</u>	183-194	(2)
1950	<u>34</u>	123-132	(8)
1950	<u>34</u>	185-188	(9)
1950	<u>34</u>	189-191	(10)
1951	<u>35</u>	154-164	(6)
1952	<u>36</u>	1-17	(18)
1956	<u>39</u>	129-144	(16)
1956	<u>39</u>	189-193	(10)
1956	<u>40</u>	152-160	(12)
1958	<u>41</u>	183-187	(12)
1959	<u>43</u>	1-5	(20)
1959	<u>43</u>	143-147	(22)
1960	<u>44</u>	87-94	(S-1)
1960	<u>44</u>	115-125	(S-2)
1960	<u>44</u>	125-134	(S-3)

SERIES A

1950	<u>A-2</u>	561-612	(6)
1953	<u>A-5</u>	533-553	(C-7)
1955	<u>A-7</u>	56-66	(27)

SCIENTIFIC PAPERS OF THE INSTITUTE OF PHYSICAL  
AND CHEMICAL RESEARCH (TOKYO)  
(Sci. Papers Inst. Phys. Chem. Research - Tokyo)

1936	<u>28</u>	243-25	(8)
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SITZUNGSBERICHTE DER OSTERREICHISCHEN AKADEMIE  
DER WISSENSCHAFTEN (Osterr. Akad. Wiss. Math.  
Naturin Kl Sitzber)

1953	Abteilung IIA	<u>162</u>	235-252 (10)
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SOVIET PHYSICS "DOKLADY" (Sov. Phys. "Doklady")

1956	<u>1</u>	145-148	(C-3)
1956	<u>1</u>	165-168	(C-4)
1956	<u>1</u>	527-529	(26)
1957	<u>2</u>	207-209	(40)
1957	<u>2</u>	251-254	(41)
1958	<u>3</u>	826-829	(3)
1958	<u>3</u>	947-948	(36)
1958	<u>3</u>	960-961	(37)
1958	<u>3</u>	1006-1009	(C-12)
1959	<u>3</u>	1249-1253	(23)
1959	<u>3</u>	1262-1265	(24)
1959	<u>4</u>	316-318	(38)
1959	<u>4</u>	826-828	(42)
1959	<u>4</u>	855-858	(8)
1959	<u>4</u>	1050-1052	(39)
1960	<u>5</u>	310-312	(9)
1960	<u>5</u>	996-998	(53)
1960	<u>5</u>	1231-1233	(43)

SOVIET PHYSICS "JETP" (Sov. Phys. "JETP")

1958	<u>3</u>	133	(C-13)
1958	<u>7</u>	414-420	(28)
1959	<u>9</u>	856-858	(6)
1960	<u>12</u>	886-890	(46)

SOVIET PHYSICS "TECHNICAL PHYSICS" (Sov. Phys.  
"Tech. Phys.")

1960	<u>5</u>	1016-1017	(15)
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TECHNOLOGY REPORTS OF OSAKA UNIVERSITY  
(Tech. Repts. Osaka Univ.)

1954	<u>4</u>	1-5	(19)
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TRUDY SEMINARA PO ZHAROSTOIKIM MATERIALAM AKAD.  
NAUK. (UKR. Inst. Metallokeram i Spetsial,  
Splavov, Kiev)

1958	<u>5</u>	15-20	(26)
1958	<u>5</u>	21-27	(20)

TRUDY STALINIRSK GOSUDARST INST.

1956	<u>3</u>	589-598	(C-8)
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1958	<u>68</u>	(8)	91-104 (24)
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1959	<u>4</u>	260-267	(27)
1960	<u>5</u>	231-234	(41)

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1953	AEC-tr-3629	6 pp.	(C-6)
1955	NP 5803	24 pp.	(33)
1955	NP 5805	16 pp.	(32)
1956	AECU 3190	75 pp.	R-14
1956	AECU 3578	81 pp.	(21)
1956	ISC-830	118 pp.	(C-9)
1957	NAASR-1839	50 pp.	(C-9)
1959	NP 7906	20 pp.	(35)
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1960	NP 8475	29 pp.	(50)

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1954	PUBL 9735	72 pp. Diss.Abs.	<u>14</u> 2096 (C-1)
1955	PUBL 10,744	108 pp. Diss.Abs.	<u>15</u> 280 (14)
1957	PUBL 21,074	93 pp. Diss.Abs.	<u>17</u> 1097-1098 (7)
1957	PUBL 19,976	137 pp. Diss.Abs.	<u>17</u> 657 (C-14)
1958	PUBL MTC-58-3076	105 pp. Diss. Abs.	<u>19</u> 547 (13)
1959	MTC-59-154	99 pp. Diss.Abs.	<u>19</u> 2365 (16)
1959	MTC-59-135	155 pp. Diss.Abs.	<u>19</u> 2368 (29)
1959	MTC-59-5891	93 pp.	(C-7)
1960	MTC-60-880	107 pp. Diss.Abs.	<u>20</u> 4142 (39)
1960	MTC-60-1197	99 pp. Diss.Abs.	<u>20</u> 4147 (26)
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1960	<u>15</u>	(No. 16) Ser Fiz i Khim (3)	36-41 (1)
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1957	(8)	209-214	(12)
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1955 46 647-650 (C-2)

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1953 8a 429-432 (6)  
1955 10a 502-503 (13)  
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1951 131 1-9 (13)  
1954 136 491-533 (8)  
1954 138 71-79 (9)  
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1957 149 412-424 (19)  
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1960 159 178-193 (21)

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1955 3 273-329 (38)  
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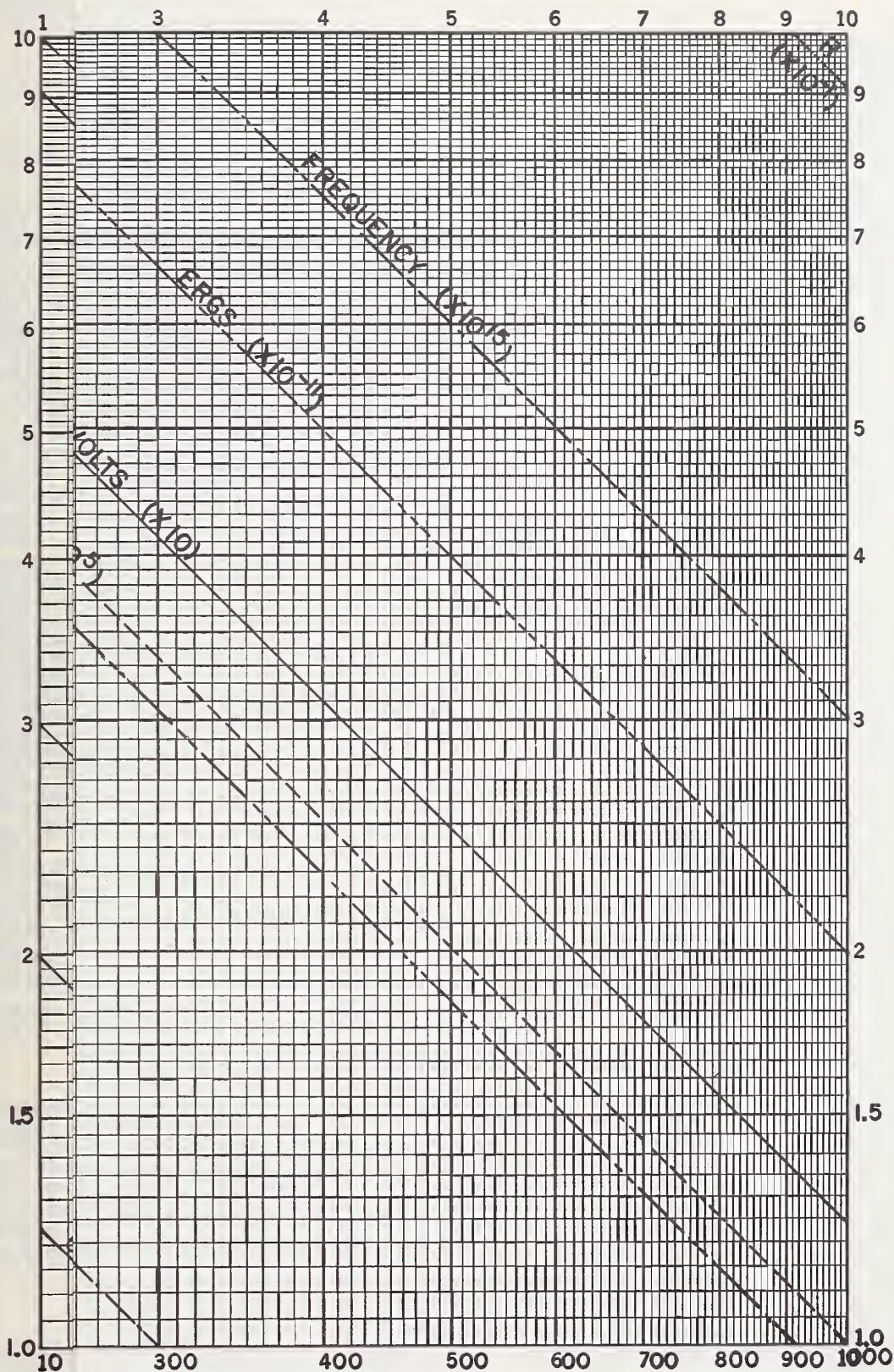
ENGINEERING INDEX

NUCLEAR SCIENCE ABSTRACTS

PHYSICS ABSTRACTS

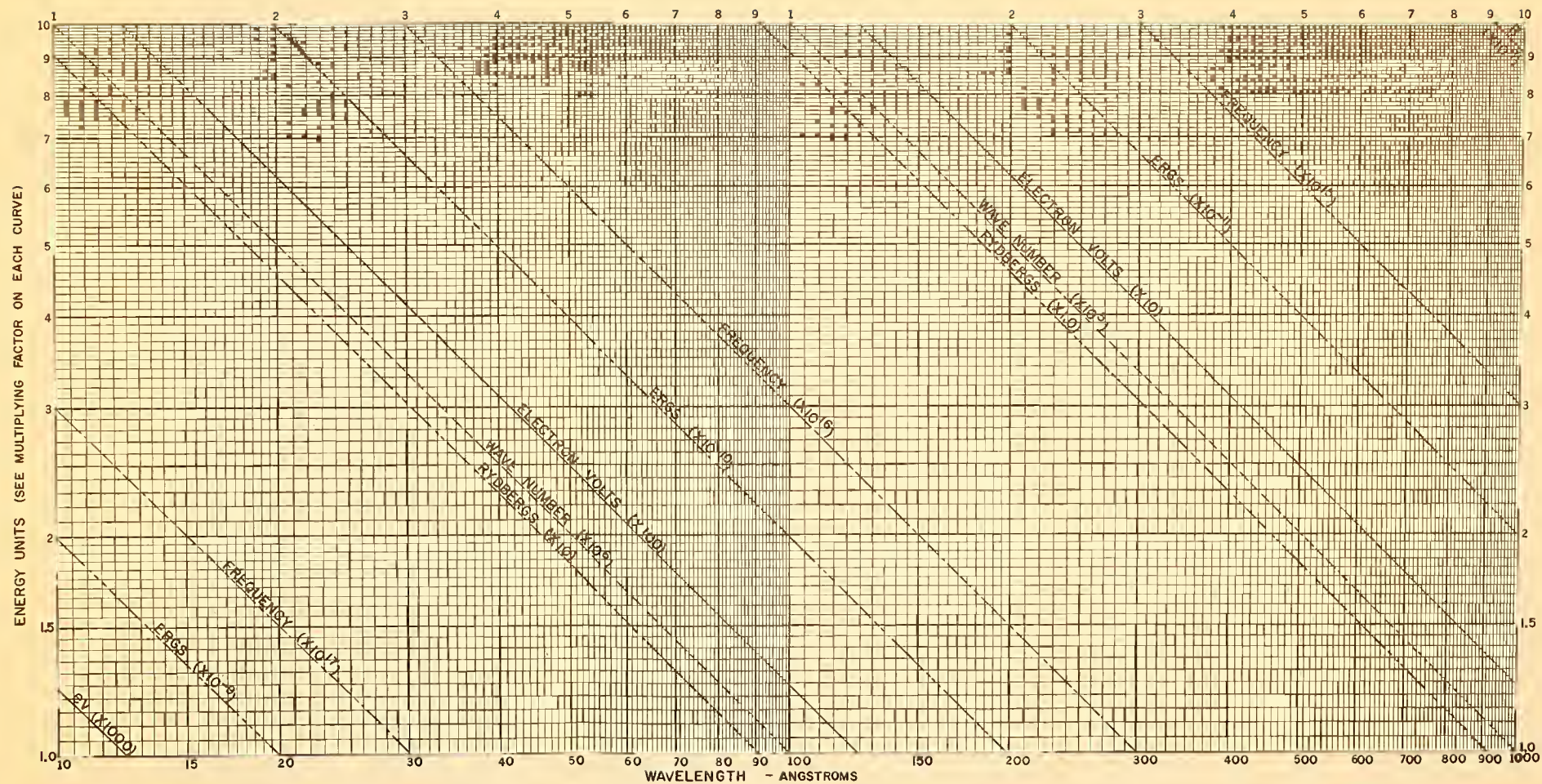


ENERGY UNITS (SEE MULTIPLYING FACTOR ON EACH CURVE)













# U.S. DEPARTMENT OF COMMERCE

Luther H. Hodges, *Secretary*

## NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*

### THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

#### WASHINGTON, D.C.

**Electricity.** Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage.

**Metrology.** Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Desimetry.

**Heat.** Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

**Radiation Physics.** X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

**Analytical and Inorganic Chemistry.** Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

**Mechanics.** Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

**Polymers.** Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

**Metallurgy.** Engineering Metallurgy. Microscopy and Diffraction. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

**Inorganic Solids.** Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

**Building Research.** Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

**Applied Mathematics.** Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

**Data Processing Systems.** Components and Techniques. Computer. Technology. Measurements Automation. Engineering Applications. Systems Analysis.

**Atomic Physics.** Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

**Instrumentation.** Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

**Physical Chemistry.** Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

**Office of Weights and Measures**

#### BOULDER, COLO.

**Cryogenic Engineering Laboratory.** Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

#### CENTRAL RADIO PROPAGATION LABORATORY

**Ionosphere Research and Propagation.** Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

**Radio Propagation Engineering.** Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

**Radio Systems.** Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

**Upper Atmosphere and Space Physics.** Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

#### RADIO STANDARDS LABORATORY

**Radio Physics.** Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Millimeter-Wave Research.

**Circuit Standards.** High Frequency Electrical Standards. Microwave Circuit Standards. Electronic Calibration Center.

